A REVISION OF AUSTRALIAN SPECIES PREVIOUSLY REFERRED TO THE GENUS *EMPOASCA* (CICADELLIDAE, HOMOPTERA).

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(Plate xv, and seventy-five Text-figures.)

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Synopsis.

This paper deals with the taxonomy of Australian species of the genus *Empoasca* (Cicadellidae, Homoptera). As a means to this end, the external morphology of the genus as a whole is discussed with special emphasis on the male genitalia. A brief account of the distribution of the species together with their known economic importance is given and the paper concludes with keys to the species, re-descriptions in detail of the already described species, and the description of two new species.

Introduction.

Few, if any, complete studies of any Australian genus of leaf-hoppers have yet appeared. From time to time, new species have been described, often without recourse either to the types or the literature, in the transactions of various Australian and overseas learned societies. For the genus *Empoasca*, this has resulted in the accumulation of unsorted species, misidentifications, synonymy, and even the inclusion of species of other genera. Important economic species parade under synonyms, while others which do not occur in Australia are recorded as doing damage to crops. The confusion so established has been unwittingly perpetuated and added to by economic entomologists.

This study has therefore been undertaken, not with a view to making extensive additions of new species, but to establish the validity or otherwise of those already described, to give adequate re-descriptions of the accepted species, and to outline their external morphology. The re-descriptions are given in more than usual detail since I concur with Mayr (1942) that the fewer species of a genus there are known, the more exact should the descriptions be. Unfortunately, all the original descriptions leave something to be desired in this respect. Six only of the previously described species are shown to be valid, and to these, two new species are added.

The facts on which my conclusions are based are as follows: I have had, for study purposes, the loan of every collection of leaf-hoppers in Australia; the only area not represented is the Northern Territory. This material included the types of the six species deposited in Australian collections as well as all specimens identified by Dr. J. W. Evans. The authorities of the British Museum and the Hawaiian Sugar Planters' Association have displayed endless patience in checking specimens with the three types in their possession, and in providing drawings of, and information about, these. To reinforce this study, I have had material collected in the field for me by the officers of the various State Departments of Agriculture. The morphological discussion has been greatly assisted by the presence, in South Australia, of enormous numbers of *Empoasca viridigrisea* Paoli in potato crops. I have read every original description and, so far as I am aware, have missed no reference to the genus in Australia.

The limited number of known species gives no real picture of the actual position of the genus in Australia, since six of the eight have been collected from cultivated crops and are therefore of more or less economic importance. The two new species show that others await collection, especially from native vegetation in the semi-arid parts of the continent.

Economic Status of the Genus.

The economic losses caused by leaf-hoppers have long been recognized in older countries, but in Australia they have not yet received the detailed consideration which they merit. If some relatively isolated examples be excepted, the damage done is not

realized; it either passes unnoticed, or is ascribed to other agencies. Such damage may be done in three possible ways.

Leach (1940) estimated that ninety per cent. of the known vectors of virus diseases of plants occur in the Homoptera of which leaf-hoppers form a large part. As yet, no species of *Empoasca* is so implicated, but this is possibly due to our lack of knowledge of the biology of many species. Many closely allied forms are well-known vectors of such diseases.

Others are toxicogenic feeders, that is, their saliva, which they inject while feeding, has poisonous effects on plants. Such is *E. fabae*, the leaf-hopper responsible for the "hopperburn" disease of potatoes in North America, a disease which, for many years, was believed to be the result of adverse climatic conditions.

Many, when their rapid multiplication is favoured by their environment, can do enormous direct harm by the withdrawal, during their feeding, of large quantities of sap from growing plants. Such outbreaks may occur when a dry season, by restricting the growth of their natural food plants, forces them to migrate to neighbouring cultivated crops where they find ideal conditions.

Normally, most species are restricted in their breeding and feeding to particular families of plants, and the introduction of new crops belonging to these families may provide new sources of food for them. This has happened with both *E. terrae-reginae*, the cotton jassid, and *E. viridigrisea*, the vegetable jassid. The former originally bred and fed on native Malvaceae, but it has now become a major factor in limiting cotton production in Queensland (May, 1950). *E. viridigrisea*, which formerly lived on native Solanaceae, has now become an established pest of potatoes and tomatoes in all parts of Australia where these crops are grown. It has, however, adapted itself to a wide range of plants of various families, having been recorded as attacking tobacco, cotton, beans, lucerne, melons, celery, beet and many different weeds. (See Plate xv and Table 2.)

Apart from such obviously destructive species, others are annually responsible for minor losses in various crops. Experimental work in the U.S.A. has shown that losses of up to twenty per cent. may occur yearly in lucerne crops as a result of the feeding of species of *Empoasca* (Poos and Wheeler, 1943). To an unknown extent in South Australia and elsewhere, *E. viridigrisea*, and in Queensland and New South Wales, *E. alfalfae*, may be so involved.

Furthermore, as cultivation in Australia is extended, with its consequent destruction of native vegetation, leaf-hoppers may be expected to become ever-increasingly important crop pests, particularly in the warmer parts of the continent and in the artificial tropical environments provided in the Murray and other irrigated areas.

Historical Résumé.

The first recorded species of the genus was described by Fabricius in 1794 as *Cicada flavescens*. This was a European insect. Others were described under various genera until Walsh (1865), in the U.S.A., erected the genus *Empoasca* for what we now know to be three colour variations of *E. fabae*. These, he called *viridescens*, *obtusa*, and *consobrina*. *E. fabae* Harris thus became the genotype.

Because colour was largely used as a distinguishing character, and this may vary considerably in the one species, while two or more species may be almost identical in colour, the taxonomy became obscure. Damage done by a single species was attributed to several supposedly different species, while a number of species was grouped as one doing different kinds of damage in widely scattered areas.

The chaotic situation which had developed was made clear, and the mistakes rectified only after the researches of De Long (1931) had revealed the highly characteristic features of the male genitalia, and proven that distinct and constant differences in these existed between the species. Using these differences as his criteria, he revised the species in America, north of Mexico, and, in a lengthy series of subsequent papers, first by himself, and later, with the aid of collaborators, added greatly to the numbers and knowledge of the North American species.

The taxonomic history of *Empoasca* in Australia follows that common to the taxonomy of Australian Insecta generally. The earliest descriptions were made by over-

seas taxonomists working on material collected in Australia. As a consequence, the older types came to be deposited in overseas collections.

The first Australian species recorded was described as *Cicadula histrionicula* by Kirkaldy (1906), from material collected in Queensland by the Koebele and Perkins' expedition in 1904. This species came from the Bundaberg district.

Two more Queensland species, *Empoasca terrae-reginae* and *E. viridigrisea*, were added by Paoli (1936) from material in the British Museum. These came from Biloela and Bowen respectively.

The following six species were all described from Queensland by J. W. Evans: *E. bancrofti* (Evans, 1939), *E. athertoni* and *E. alfalfae* (Evans, 1941), *E. maculata* (Evans, 1942*a*), and *E. malvae* and *E. pulcherrima* (Evans, 1942*b*).

As will be shown later, *E. athertoni* is not an *Empoasca*, while *E. maculata* and *E. pulcherrima* are synonyms for *E. terrae-reginae* and *E. histrionicula* respectively.

The genus therefore contains six valid, described species, and to these, I now add *merredinensis* and *bractigera* bringing the number of species known to eight.

Distribution of the Genus (See map, Text-fig. A).

As stated above, six of the eight known species have been described from Queensland, to which State, so far as collections and records show, three of them, *histrionicula*, *terrae-reginae*, and *malvae*, are confined. Two species occur in New South Wales as well as in Queensland. These are *alfalfae*, apparently common in both States, and *bancrofti*. The latter insect is rare in collections. The single specimen of *bractigera* came from Mt. Keira in New South Wales, while all the specimens of *merredinensis* were collected near the town of Merredin in Western Australia.

In very great contrast to the apparently limited habitats of these species, is the exceptional distribution of *E. viridigrisea*, which ranges all over coastal Australia. It is found all along such areas of Queensland as a common pest of tomatoes and lucerne. It occurs in similar areas of New South Wales on potatoes, tomatoes, beans and lucerne. In Victoria, it has been collected far inland on tobacco plants.

I first identified specimens of it in South Australia in 1950. These came from the irrigation districts of Renmark and Berri, where they were infesting crops of tomatoes and potatoes. Shortly afterwards I collected it on cultivated Cucurbitaceae at Marion. A very heavy infestation destroyed a large area of potatoes at Athelstone, and at the same time it was common in lucerne at Mitcham.

In Western Australia the insects were first collected in 1942. These, and later specimens, came from districts as far apart as Manjimup in the south and Wyndham in the north. In these areas they were infesting solanaceous crops, other vegetables, and home gardens.

The fact that the one species is common wherever its introduced hosts are cultivated is very suggestive. Specimens from places as far apart as Wyndham in Western Australia, Adelaide in South Australia, Nathalia in Victoria, and Charters Towers in Queensland are identical. I have been unable to find either colour or morphological differences in specimens from these or any other areas in Australia, and this statement is based on the study of more than 2,400 specimens from all parts of the continent. Were the species endemic in these areas, one would expect that evolution would have resulted in at least a tendency towards sub-speciation. That such has not occurred when the environmental conditions are so varied, and when it is remembered that almost insuperable barriers to prevent natural dispersal exist, one is forced to the conclusion that this insect has been distributed through the agency of cultivated solanaceous crops since the coming of white settlement. This subject is of such interest that I intend to deal with it in a future paper.

A careful search of literature and collections, as well as of the records of the Tasmanian Department of Agriculture, has failed to reveal any species of *Empoasca* in Tasmania, though I anticipate that *E. viridigrisea* will yet be found in those parts of the island where potatoes are grown.

The Genus and its Systematic Position.

Until 1931 the genus was regarded as one of world-wide distribution, having native species in all the continents. In that year De Long (1931) demonstrated that the "genus" was much more complex than had previously been thought, and since then it has undergone subdivision.

De Long grouped the then known North American species into four subgenera. These, in a recent letter to me, he states he has now raised to full generic status and is erecting one or more genera for Mexican species.

His four North American genera are *Empoasca* s.str. Walsh (1865), *Kybos* Fieber, 1866, *Hebata* De Long (1931) and *Idona* De Long (1931).

Text-figure A.—Map showing known distribution of *Austroasca* in Australia.

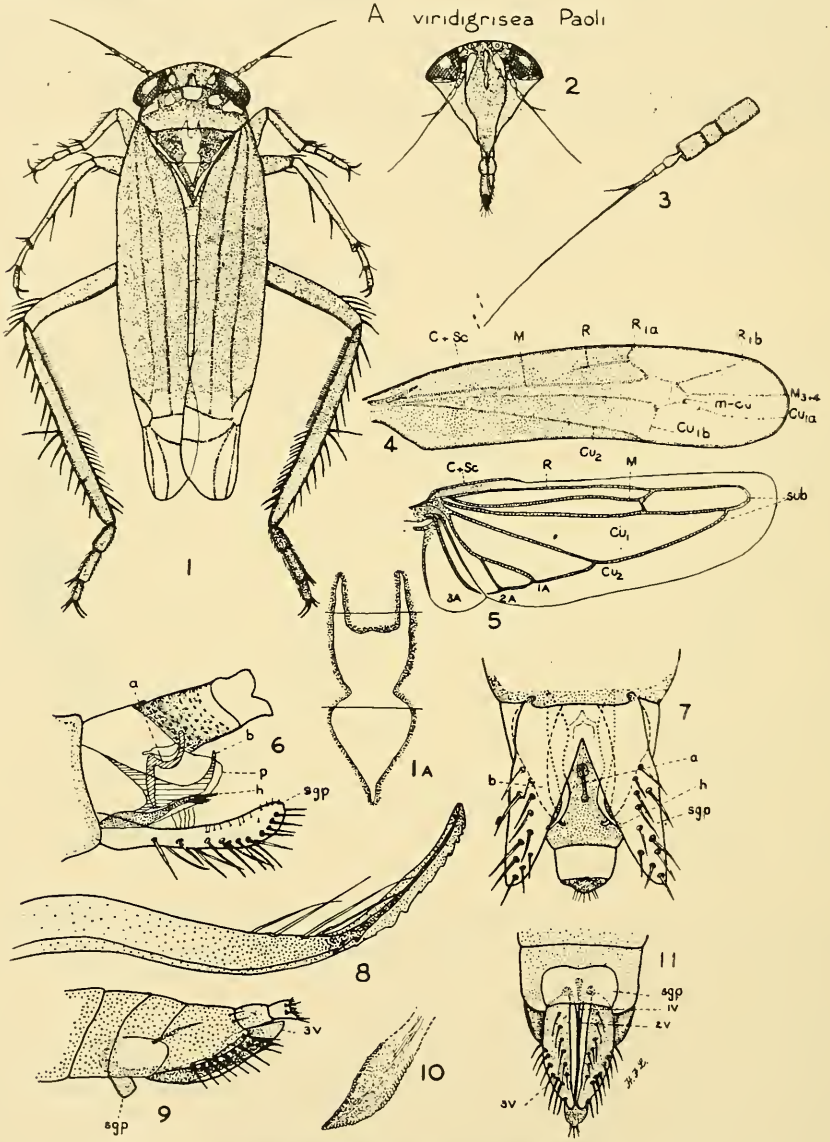
The map has been made from actual records only. The shaded areas are those in which *A. viridigrisea* is known to occur. The circles show where the other species have been collected. 1. *A. terrae-reginae.* 2. *A. alfalfae.* 3. *A. histrionicula.* 4. *A. malvae.* 5. *A. merredinensis.* 6. *A bancrofti* 7. *A. bractigera.*

Zakhvatkin (1946) has restored Fieber's old generic name *Chlorita* for certain Asiatic species, dividing it into the subgenera *Chlorita* s.str. and *Eremochlorita.*

To these I now add *Austroasca*, gen. nov., to include the Australian species formerly included in *Empoasca*, and subdivide it into *Austroasca* s.str. and *Paolia.* The distinguishing characters of the new genus are given below.

As knowledge of the whole "group" increases, the number of genera must be likewise increased. At present there is so little knowledge of the genera and species, more especially in Asia, Africa, and Australia, that I am unable to make use of the recognized taxonomic terms "tribe" or "group" for the assemblage of genera, since possibly no one at present is in a position to circumscribe it; at the same time the need is urgent for a term which will indicate the existence of such an unsorted and unknown "group" of genera. For such a "group" of genera I propose the use of the termination *iti* and refer to all the genera of "*Empoasca*" as the *Empoasciti.* No

taxonomic significance is to be attached to the term. It is purely one of convenience and signifies that such a "group" of genera exists and awaits the attention of a future specialist, having at his command a representative collection from all parts of the world so that the relationships between the genera can be defined and all these then placed in their correct taxonomic category.



Text-figures 1-11.—*A. viridigrisea* Paoli.

1, complete insect, × 9; 1A, details of median white mark on scutellum; 2, face, × 9; 3, antenna, × 109; 4, tegmen, × 9; 5, hind wing, × 9; 6, male genitalia (lateral view), × 27; 7, male genitalia (ventral view), × 27; 8, apical part of harpagone, × 109; 9, female genitalia (lateral view), × 9; 10, blade of first valvula of ovipositor, × 109; 11, female genitalia (ventral view), × 9.

The Empoasciti belong to the family Cicadellidae of the order Homoptera. They constitute a well-defined natural group of leaf-hoppers, slender, and usually of small size, few exceeding 5 mm. in length (Text-fig. 1).

Austroasca resembles the other genera of the Empoasciti in all major morphological structures except the dorsal hooks (see below). These have undergone such a reduction as to be vestigial or no longer in existence.

External Morphology of Austroasca.

In this section I deal with the external morphology of the Empoasciti, pointing out, in the appropriate places, those features which are characteristic of *Austroasca*.

The Head. (See Text-figs. 12, 30, 38, 45, 53, 59, 68.)

When any species of leaf-hopper is viewed dorsally, the insect being so orientated that the dorsal surfaces of the head and pronotum are in a horizontal plane, the visible part of the head is the crown (Evans, 1946). This is seen to project medially to a greater or lesser extent beyond the eyes, the extent of the projection (the crown production) varying according as the horizontal is departed from. In order to be able to make comparisons, a standard position must be adopted, and all the heads figured in this paper have been so orientated before drawing. The term has no morphological significance since it may comprise different morphological structures in different genera; it is merely a convenient term for descriptive purposes. The crown may be roundedly or angularly produced. In the Empoasciti it never includes any part of the fronto-clypeus.

In *Austroasca* it is always broadly, more or less roundedly produced, and the sharp, pointed crown characteristic of the genus *Idona* De Long never occurs. On either side, anteriorly, the dorsal half of each eye can be seen. The ocelli may or may not be partly visible in the standard position. They are never completely visible. As in leaf-hoppers generally, the crown is a very plastic feature and among the known species of *Austroasca* little correlation exists between crown shape and other morphological characters.

For purposes of comparing the extent to which the crown projects in different species I use what I term the Coronal Index (C.I.). This may be found as follows: An exact drawing of the crown is first made and the distance between the eyes measured at their anterior, visible, inner margins is the Eye Width (E.W.) (Text-figs. 20 and 21). The distance from the line joining these points to the anterior margin of the crown, measured medially, is the Crown Production (C.P.) (Text-figs. 20 and 21). From these measurements the Coronal Index is obtained by $C.I. = \frac{C.P.}{E.W.} \times 100$ (Text-figs. 20 and 21) and is a number, varying within very small limits, characteristic of each species irrespective of the considerable variations in size which occur among individuals of any given species. In some species, for example, *A. terrae-reginae*, slight sexual differences in the index occur, but these are never so large as to confuse the issue. The index for each species is an average. In the case of *A. viridigrisea*, more than two thousand specimens were measured. In all other species the index is an average of all the specimens available, as shown in Table 1. In no instance was the variation between minimum and maximum more than 1·5 per cent, an amount which, for this purpose, is insignificant.

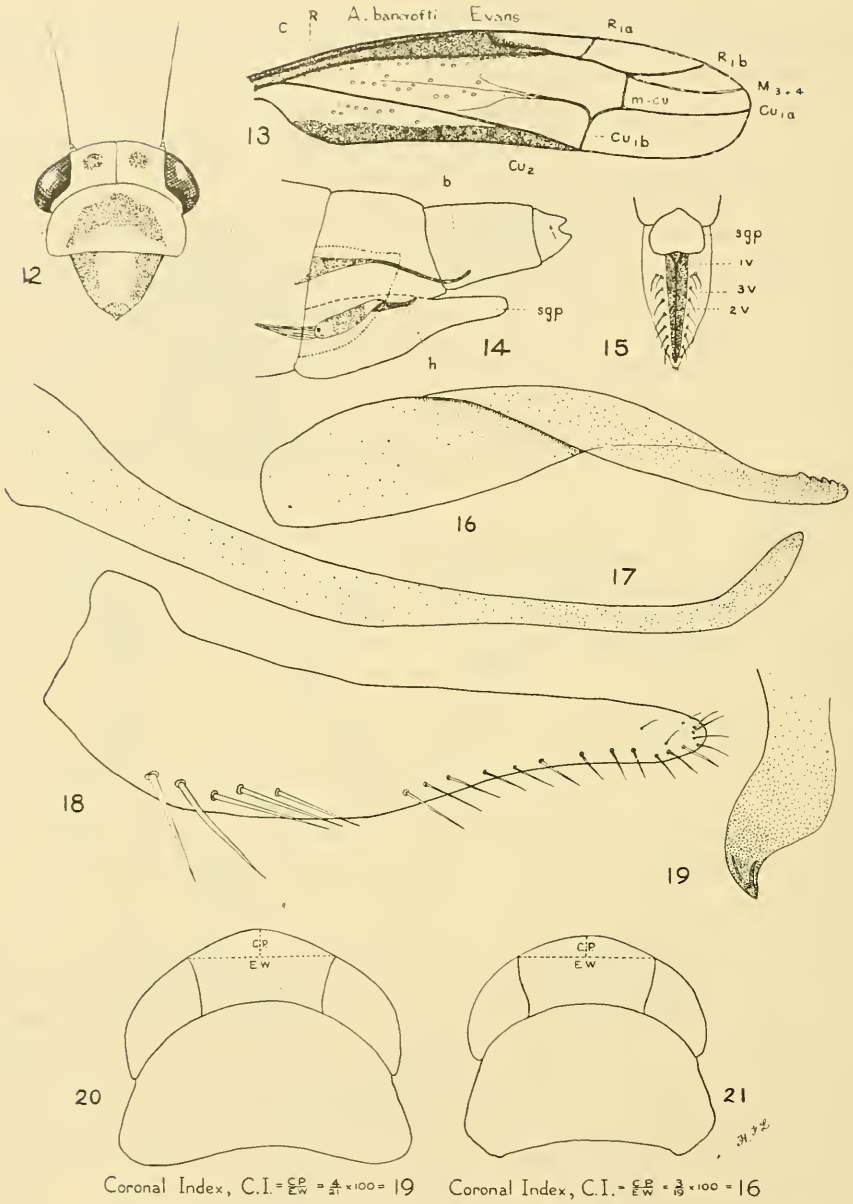
Crowns having a C.I. of 20 or more are obviously produced. Such are those of *A. terrae-reginae* (C.I. = 27, Text-fig. 53), *A. merredinensis* (C.I. = 27, Text-fig. 59), and *A. alfalfae* (C.I. = 23, Text-fig. 45).

Crowns having a C.I. of 15 or less tend to have their anterior and posterior margins broadly rounded and parallel. This group includes *A. bractigera* (C.I. = 10, Text-fig. 68), *A. bancrofti* (C.I. = 13, Text-fig. 12) and *A. viridigrisea* (C.I. = 13, Text-fig. 1).

In crowns of the intermediate group the production is not very obvious, though the anterior and posterior margins are no longer parallel. Such are *A. malvae* (C.I. = 19, Text-fig. 30) and *A. histrionicula* (C.I. = 17, Text-fig. 38).

The Face. (Text-fig. 2.)

When the head is viewed ventrally, three median sclerites are visible. These collectively form what is referred to as the face, and comprise a small, triangular



Text-figures 12-19.—*A. bancrofti* Evans.

12, crown, pronotum and scutellum, × 9; 13, tegmen showing peculiarities of venation, × 9; 14, reconstruction of male genitalia (lateral view), × 27; 15, female genitalia (ventral view), × 9; 16, harpagone, × 109; 17, brachone, × 109; 18, subgenital plate, × 22; 19, dorsal hook, × 109.

Text-figures 20 and 21.—Methods used in determining Coronal Index.

labrum, above which is the sub-rectangular ante-clypeus, while uppermost is a large, long sclerite, the "clypeus" of Snodgrass (1935), or preferably the fronto-clypeus of Evans (1946). In the Empoasciti the fronto-clypeus never transgresses on to the crown. Underneath the labrum lies the long and rather stout labium. The three median sclerites are long relative to their width, and this makes the face narrow and elongate. The facial sutures are usually difficult to observe.

On either side of the fronto-clypeus, and near its upper limit, is an ocellus. Each lies between the post-frontal sutures (Evans, 1946) and the eye. Sometimes they are situated on the corono-facial angle. The two ocelli vary somewhat in size in different species, but are never large and obvious.

On either side, near the termination of the frontal sutures (Evans, 1946) and close to the eyes, are the antennae (Text-fig. 3), which are about equal in length to the face. Each consists of a large scape, pedicel and third segment. Then follows a number of much smaller segments, the antenna terminating in a long flagellum. The antennal ledges over the bases of the antennae are vestigial.

The Thorax. (Text-figs. 12, 30, 38, 45, 53, 59, 68.)

The thorax is well developed. It consists of a wide, rather long pronotum, concave on its posterior margin, and a triangular scutellum.

The Tegmina. (Text-figs. 4, 13, 37, 44, 52, 58, 67, 74.)

The forewing or tegmen is long, narrow, slightly curved, and thickened on its basal three-quarters. Its venation is highly characteristic. In dealing with this I follow, with slight modifications, the notation of Evans (1946), who has given the most satisfactory interpretation so far suggested.

In the Empoasciti the general plan is as follows (Text-fig. 4). The anterior margin of the tegmen consists of C + Sc combined. Four long veins, R, M, Cu_1 and Cu_2, occur. R divides into two branches, R_{1a} and R_{1b}, both of which tend towards the costal margin of the tegmen. R_{1b} always reaches the margin; R_{1a} may or may not do so. R_s is always absent. The second long vein is M, which terminates at the tegmen apex as M_{3+4}, the anterior branch M_{1+2} always being suppressed. M may or may not unite with R in the apical part of the tegmen as R + M. The third long vein is Cu_1. This branches, at about two-thirds of its length from the base of the tegmen, into Cu_{1a}, which reaches the margin at the tegmen apex and runs sub-parallel to M_{3+4}. The second branch, Cu_{1b}, turns almost at a right angle and meets the posterior margin of the tegmen. The fourth long vein, Cu_2, terminates in the posterior margin of the tegmen very close to the termination of Cu_{1b}. A maximum of two cross-veins, r-m and m-cu, may be present. The cross-vein m-cu is always present; r-m is present only when the veins R and M retain their separate identities (Text-figs. 52, 58, 74). When R and M unite to form the combined vein R + M (Text-figs. 4, 13, 37, 44, 67) it is part of M which connects R_{1b} to M_{3+4}. The venation is distinct in the apical third only of the tegmen. The thickening of its basal two-thirds and the thinning of the veins in this region make these very difficult to see. Anal veins are never present.

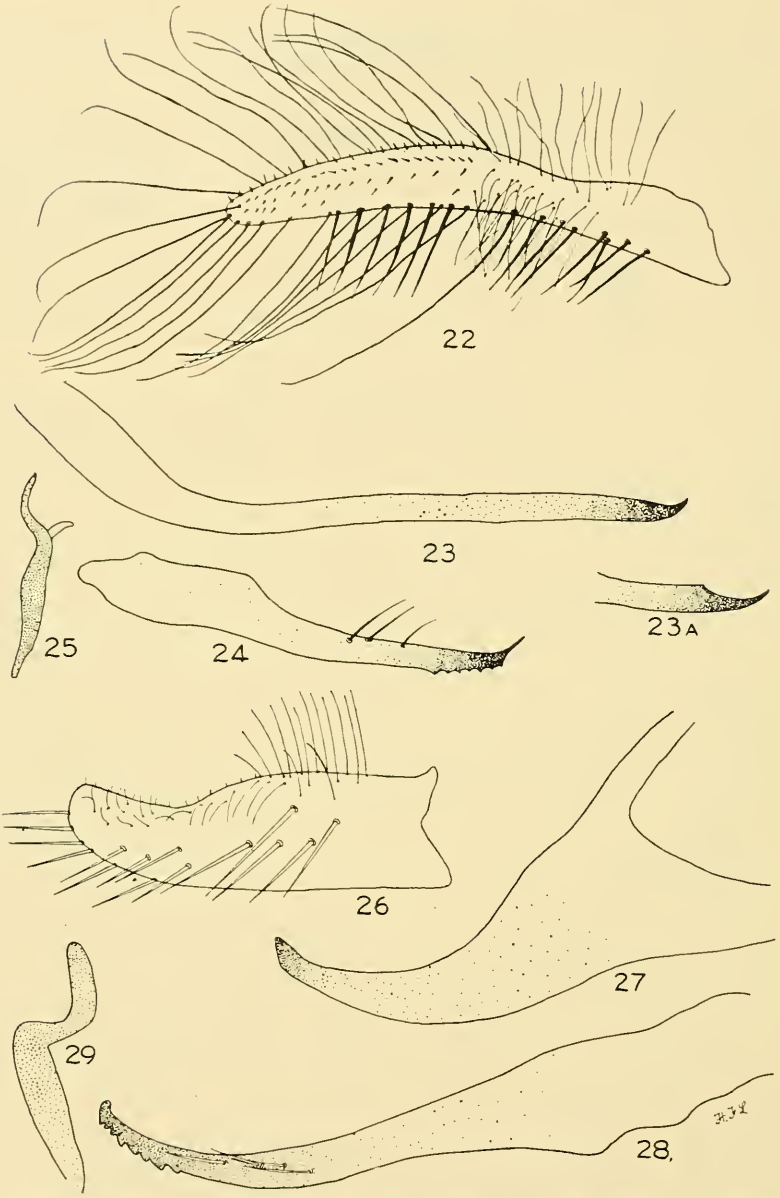
All veins from R_{1b} to Cu_2 reach the margin of the tegmen, and an appendix is therefore never present. (An appendix is formed when the terminations of the veins, instead of attaining the tegmen margin, are united by a sub-marginal vein (Text-fig. 5, sub) which connects the ends of some or all of the veins, leaving a veinless area or appendix between it and the margin.)

The principal variations in the tegmen venation of *Austroasca* will be pointed out as each species is dealt with later. One feature, however, may be mentioned here. In all the specimens I have seen, the basal part of the tegmen is covered with a layer of wax-like material which gives the tegmen a "mealy" appearance. Specimens which have been stored in preserving fluids containing alcohol do not show this layer, since it has been dissolved.

The Hind Wing. (Text-fig. 5.)

The venation is again characteristic. Near the base the combined vein C + Sc forms a thickened anterior margin to the wing, making a kind of "shoulder". It terminates suddenly near the end of this "shoulder". The remainder of the wing margin is very thin and difficult to observe.

Six long veins occur, R, M, Cu_1, Cu_2, 1A + 2A, and 3A. The tips of all these veins are united by a sub-marginal vein (Text-fig. 5, sub) and hence none of them reaches the wing margin. Between the sub-marginal vein and the wing margin is a large



Text-figures 22-29.—*A. terrae-reginae* and *A. viridigrisea* (re-drawn from Paoli).

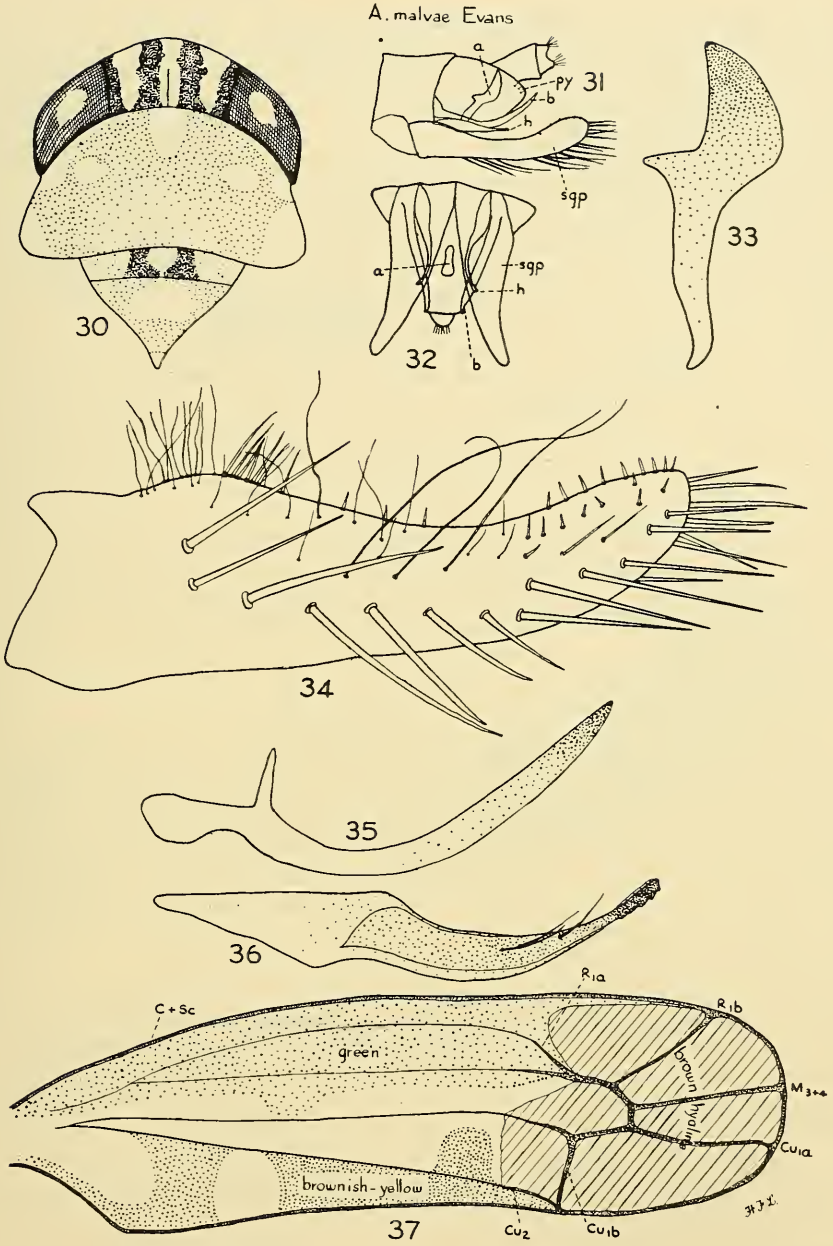
22-25, *A. terrae-reginae*.—22, subgenital plate; 23, brachone; 23A, tip of brachone showing concave notching; 24, harpagone; 25, aedeagus.

26-29, *A. viridigrisea*.—26, subgenital plate; 27, brachone; 28, harpagone; 29, aedeagus.

veinless area. 1A + 2A, before joining the sub-marginal vein, forks into 1A and 2A. A single, large, sub-rectangular apical cell is always present, closed by the sub-marginal vein. Pre-apical closed cells never occur.

The Legs. (Text-fig. 1.)

The first two pairs of legs are of the generalized cicadellid type and need no comment. The hind legs are long. Their femora bear a few strong spines distally. The somewhat flattened tibiae bear strong spines in two or three series, more particularly on the distal halves. The basal half of each tibia has a ventral comb of short bristles.



Text-figures 30-37.—*A. malvae* Evans.

30, Crown, pronotum and scutellum; 31, male genitalia (lateral view); 32, male genitalia (ventral view); 33, aedeagus; 34, subgenital plate; 35, brachone; 36, harpagone; 37, tegmen.

The Abdomen.

This is typical of the Cicadellidae generally.

The Genitalia.

The female genitalia (Text-figs. 9, 10, 11, 15) follow the generalized homopterous pattern and as this has been adequately discussed by Snodgrass (1935) little more need be added. Only slight variations occur among the species of *Austroasca.* The female genitalia are always large, prominent, and heavily bristled.

The male genitalia are highly specialized and are characteristic. In discussing them I use the terminology which Snodgrass (1935) adopted for his generalized description of the male genitalia of the Homoptera, adding new terms for those structures only which are peculiar to the Empoasciti, and giving these Greek names so as to be in harmony with his terminology.

The aedeagus excepted, all elements of the male genitalia are paired, each member of a pair being the mirror image of its fellow. The genitalia proper are so enclosed as to be visible in prepared sections only.

From the lateral margins of the ninth abdominal dorsum there extends downwards and posteriorly a pair of large lobes. The combined structure thus formed by the dorsum and its lobes is called the *pygophore* (py, Text-figs. 31, 39, 46, 54, 60, 69), and it encloses dorsally and laterally the genitalia proper.

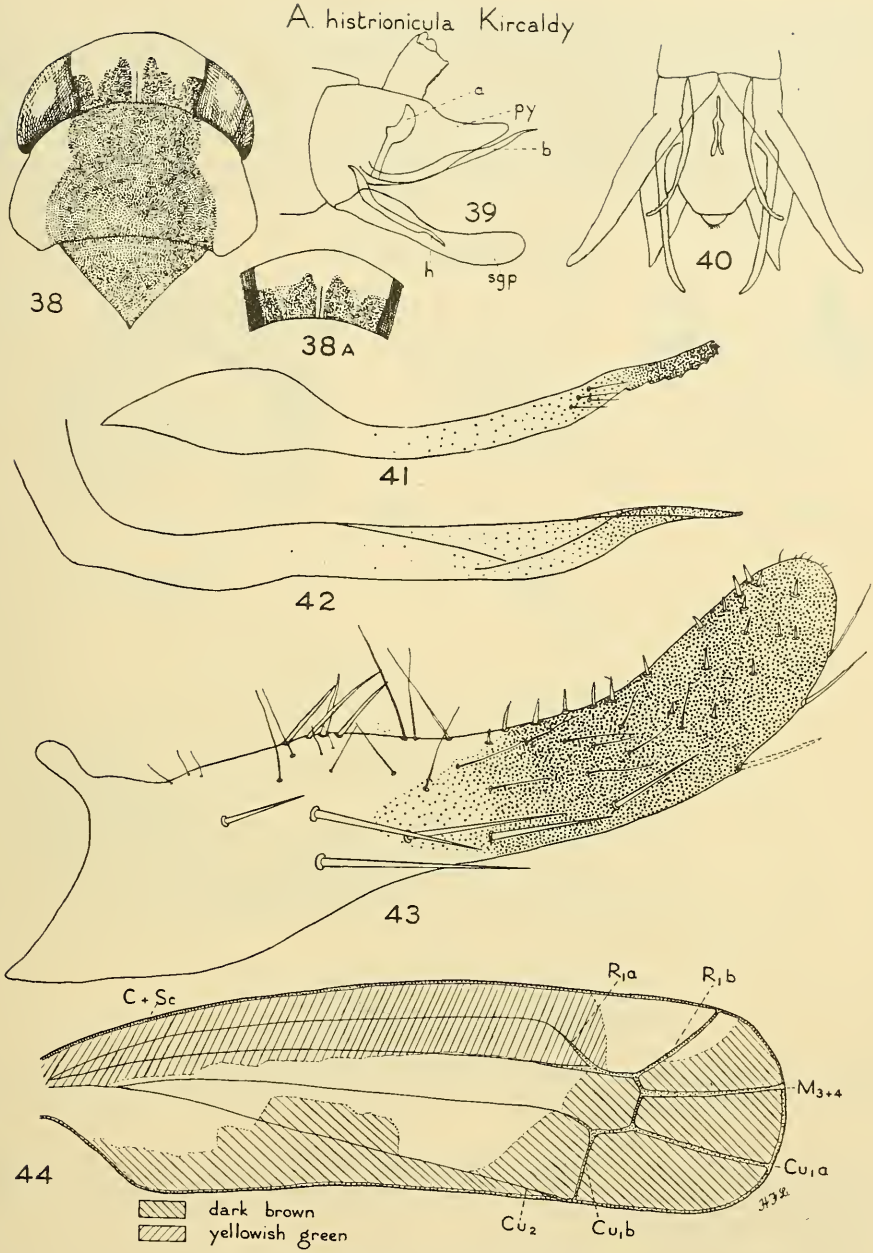
From the ninth abdominal sternum there grow out two large, elongate, carinate lobes which extend posteriorly to form the floor of the genital atrium. These are the sub-genital plates (sgp, Text-figs. 6, 7, 14, 31, 39, 46, 54, 60, 69). In *Austroasca* their tips are always upturned. They are always more or less heavily bristled, their chaetotaxy being characteristic for each species. From two to four types of setae may be present. Long, strong, thick, pointed bristles always occur. These are the ensiform bristles. Along the apical half of the dorsal margin there is usually a row of very short, stout bristles, the marginal setae. Similar setae may also be scattered over the outer surface of the apical parts of the sub-genital plates. Sometimes there occur very long bristles, thick at the base and then rapidly tapering, ending in long flagella. These are the flagellate bristles: they attain their greatest development in *A. terrae-reginae* (Text-fig. 57). They occur to a lesser extent in *A. alfalfae* (Text-fig. 51). Finally, thin scattered hairs of medium length may occur in various parts, but more especially towards the base (Text-figs. 26, 34, 51, 57).

The genitalia proper consist of an aedeagus and two or three pairs of claspers. The lower pair of claspers are the harpagones (h, Text-figs. 6, 14, 31, 39, 46, 54, 60, 69). These are usually short and stout, and are always strongly sclerotized. Their bases bear strong muscular attachments, the muscles controlling them being in the eighth abdominal segment. Their muscular attachments readily distinguish them from other members of the genitalia. They terminate in denticulations on the ventral side only. Just before the denticulations begin, a small, variable number of strong bristles is found. The position and number of the bristles, and the shape and number of the denticulations are specific characters (see Text-figs. 24, 36, 41, etc.).

From the lateral walls of the pygophore there arises internally a pair of prominent accessory structures whose purpose is to aid the harpagones during copulation. These have no muscular attachments but are always strongly sclerotized, particularly towards their apices. They are usually referred to as "lateral processes of the pygophore". As these must be repeatedly referred to in descriptions, and as the above expression is somewhat lengthy and indefinite, I propose to call them brachones (that is, arms). They are always much larger and more conspicuous than the harpagones, vary greatly, in different species, in shape, length and curvature, and in themselves are often sufficient for specific determination. They may be long and slender (Text-figs. 17, 23, 42), sail-like with broad bases and tapering tips (Text-figs. 27 and 63), almost straight (Text-fig. 17) or strongly curved (Text-figs. 49 and 63). Their tips may be merely tapered (Text-figs. 17 and 35) or may be sculptured in various ways (Text-figs. 23A and 49). In *A. bractigera* they are in the form of wide flat plates notched along the apical margin (Text-fig. 72). They are one of the most plastic units of the anatomy of the Empoasciti.

The aedeagus consists of a basal, more or less straight, attached portion and a free dorsal portion. This latter consists of a pair of lobes whose size, shape and curvature vary considerably in different species (Text-figs. 33, 56, 65).

The two terminal segments of the abdomen, segments X and XI, together comprise what is known as the anal tube. From its base, in most genera, there descends into



Text-figures 38-44.—*A. histrionicula* Kirkaldy.

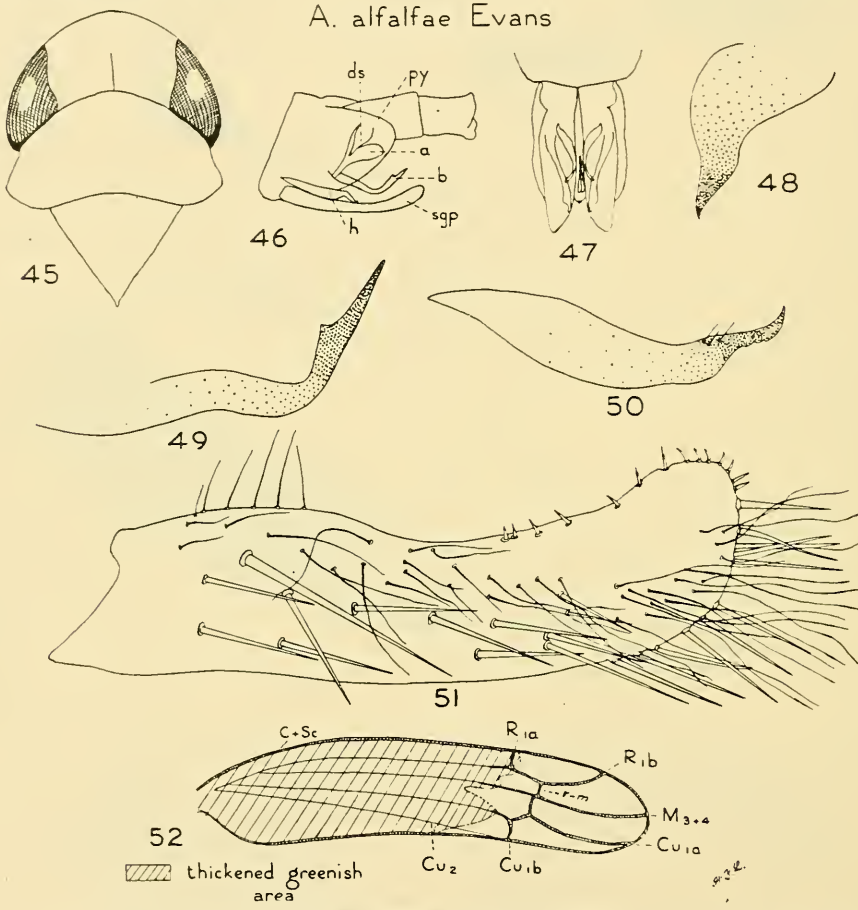
38, crown, pronotum and scutellum; 38A, variation in crown markings; 39, male genitalia (lateral view); 40, male genitalia (ventral view); 41, harpagone; 42, brachone; 43, subgenital plate; 44, tegmen.

the genital atrium a pair of strong, usually curved, hooks. These are developed from the tenth abdominal dorsum and serve, in those genera possessing them, as a third pair of claspers. These are the dorsal hooks. They are greatly reduced in *Austroasca*, where they are either vestigial or entirely absent. When present, they are very small, bluntly-pointed protuberances (ds, Text-fig. 46, and Text-figs. 19, 48, 62).

Diagnosis of Austroasca, gen. nov.

Genotype, *Austroasca viridigrisea* Paoli (1936).

The general morphological characters of the Empoasciti are shared by all its genera. Those characters which separate *Austroasca* from its allies are: The crown is always wide relative to the distance between its anterior and posterior margins; it is broadly, roundedly produced, the extent of the production never being great. In no known species is a C.I. of thirty or more found. Both male and female genitalia are heavily bristled, ensiform bristles being always present and obvious. Dorsal hooks are either vestigial or absent.



Text-figures 45-52.—*A. alfalfae* Evans.

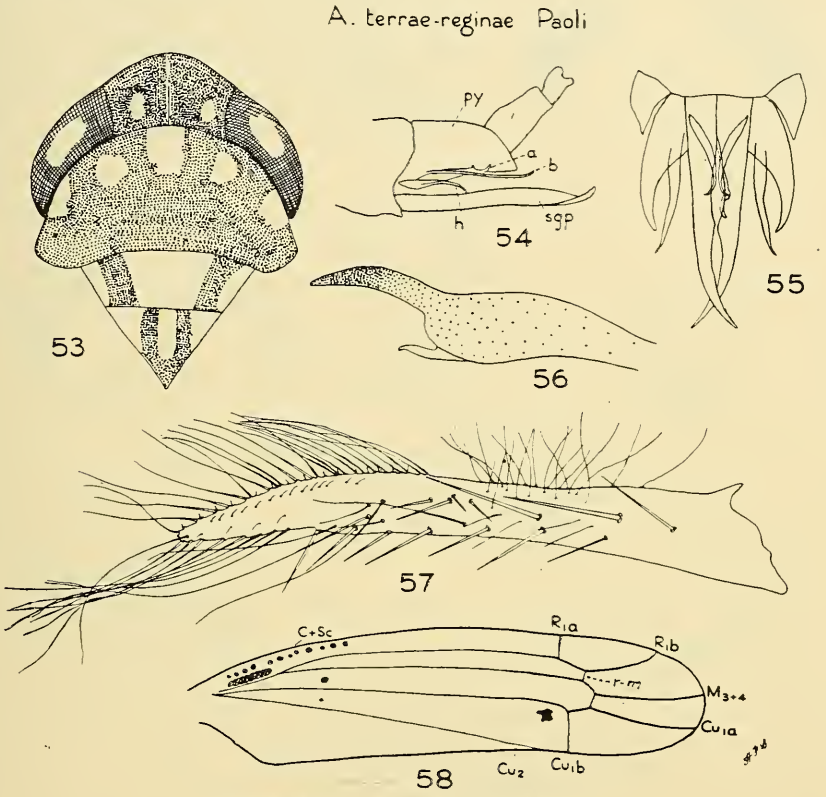
45, crown, pronotum and scutellum; 46, male genitalia (lateral view); 47, male genitalia (ventral view); 48, dorsal hook; 49, brachone; 50, harpagone; 51, subgenital plate; 52, tegmen. Note R and M distinct and presence of r-m.

In its affinities *Austroasca* most closely approaches the *obtusa* group of species of Fieber's genus, *Kybos*. In both, the crowns are broadly, roundedly produced and the genitalia are heavily bristled. It differs greatly in the weakly developed or absent dorsal hooks which, in *Kybos*, are prominent. *Kybos* is a North American genus. It is probable that when the homopterous fauna of south-east Asia and Indonesia is better known, more closely related genera will be found in these areas.

Characters Used in the Classification of Species.

With the small number at present known it is relatively easy to separate the species of *Austroasca*, shortly after death, by colour differences. As the insects dry, however,

great changes in the original colours occur. Blue and green (the latter a very common colour in the Empoasciti) become a nondescript grey, and yellow tends to whiten. White marks, originally present, may be lost, while a white pattern, not present in life, may develop through various causes. The only colours permanent under all conditions are black and brown. Specimens stored in liquids turn white except for such brown or black marks as were originally present. As has been the experience in other parts of the world, the discovery of new species will make even more difficult, and ultimately impossible, specific separation on a colour basis alone.



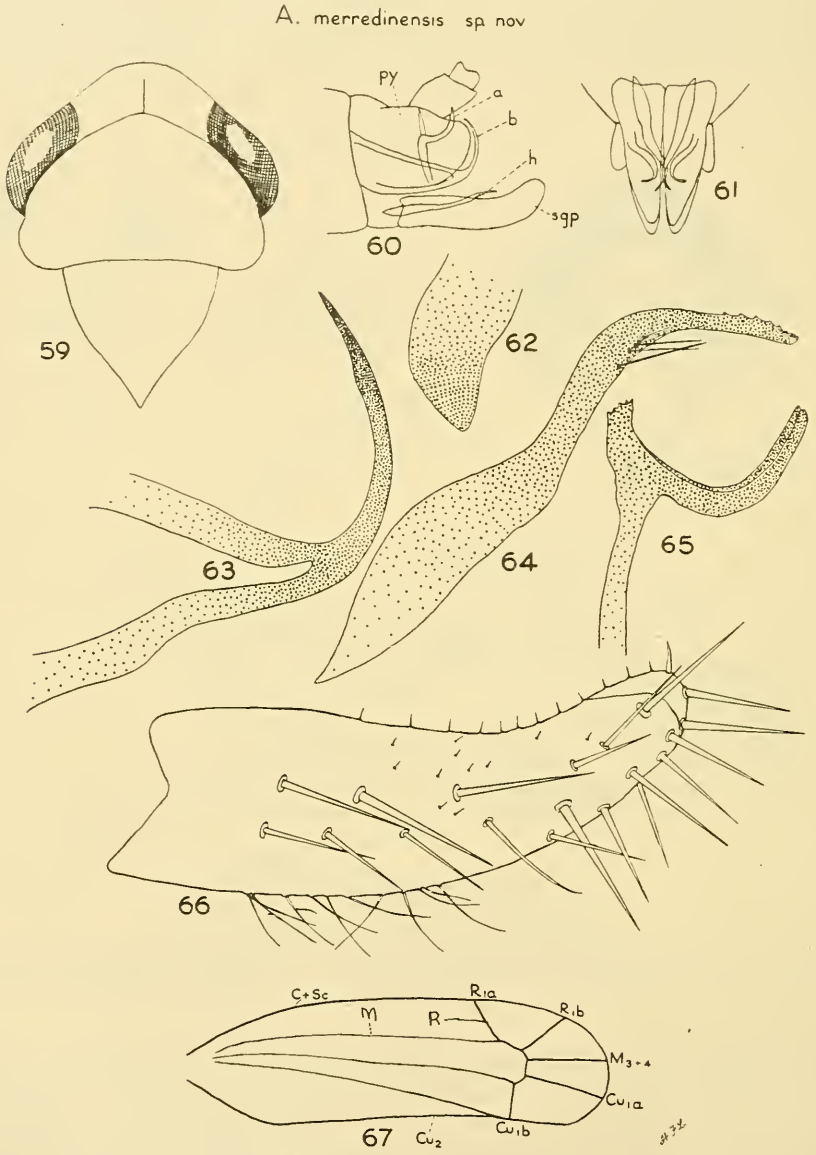
Text-figs. 53-58.—*A. terrae-reginae* Paoli.

53, crown, pronotum and scutellum; 54, male genitalia (lateral view); 55, male genitalia (ventral view); 56, aedeagus; 57, subgenital plate. Note great development of flagellate bristles; 58, tegmen showing location of spot in cell Cu_1 and presence of r-m. R and M separate veins.

For satisfactory determination of species, evanescent characters such as colour (black and brown excepted) must therefore give way to characters which, irrespective of the method or duration of preservation, will remain unchanged. Such stable characters must be morphological, and are to be found in the venation of the tegmen, the Coronal Index, and the male genitalia. Of these, the latter are of first importance. When viewed laterally and ventrally, the general arrangement of the parts, and the shape of each part, are characteristic for each species. Useful confirmatory evidence is provided by the detailed structure of the brachone and harpagone, and the chaetotaxy of the subgenital plate.

Adoption of these characters implies that new species shall not be described from females alone. In the absence of good characters, identification of known female forms is difficult; to set up new species without being able to separate them at any time from the described forms is poor taxonomy. Where the species is of economic importance,

both sexes will occur together; if the would-be identifier has no males in the material, the remedy is obvious. To help the worker who may have female material only, I have included separate keys for each sex, but the makeshift nature of the key for females must be borne in mind.



Text-figures 59-67.—*A. merredinensis*, sp. nov.

59, crown, pronotum and scutellum; 60, male genitalia (lateral view); 61, male genitalia (ventral view); 62, dorsal hook; 63, brachone; 64, harpagone; 65, aedeagus; 66, subgenital plate; 67, tegmen.

A few words on the description of new species of the Empoasciti may not be out of place here. To define the species clearly, figures are of much more value than verbal descriptions. Apart from what else it contains, a description which does not figure the male genitalia as a whole from both the lateral and ventral aspects, and separate details of the structure of the parts of the genitalia, cannot be regarded as adequate. Without

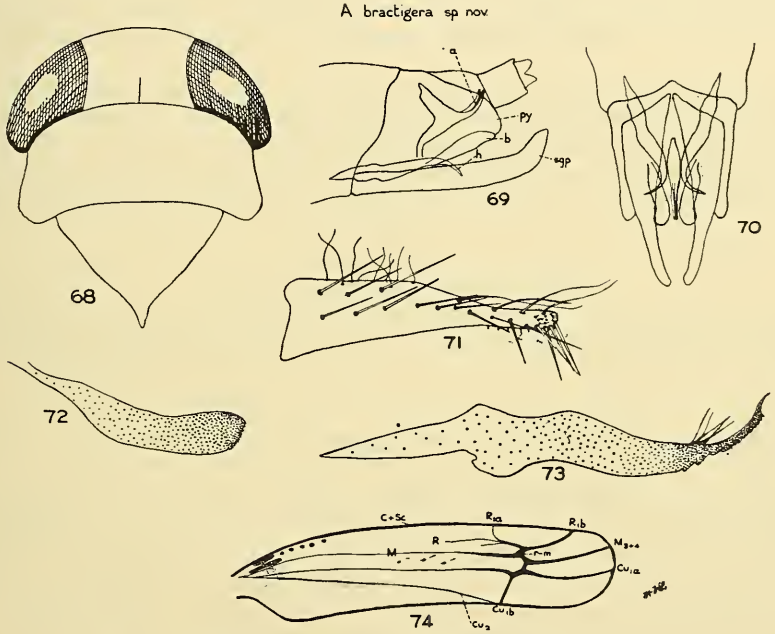
these figures, future identification is uncertain; with them, no question can ever arise as to what species is referred to.

Methods of Study and Techniques Used.

The Coronal Index is first found as explained above. This limits the number of possible species to which the specimen may belong, and this number is further limited by the nature of the tegmen venation.

The next step consists in the preparation of the male genitalia so that the parts can be clearly seen. After giving various methods a trial, I have finally standardized on the following, which meets all my requirements:

If the insect has been freshly killed, or has been stored in a liquid medium, the terminal five or six segments of the abdomen are removed. This is done with fine needles, made by using the smallest entomological pins, with the heads cut off, in metal holders. In dried specimens, the same segments may be removed with a small pair of very sharp scissors.



Text-figures 68-74.—*A. bractigera,* sp. nov.

68, crown, pronotum and scutellum; 69, male genitalia (lateral view); 70, male genitalia (ventral view); 71, subgenital plate; 72, brachone (note characteristic shape and denticulations); 73, harpagone; 74, tegmen.

The sections are put in 20 per cent. caustic potash solution and left therein until they have cleared as is shown by all the elements of the genitalia becoming plainly visible. No heat should be applied, as this usually produces distortion. Dried insects clear more rapidly than those which have been stored in preserving fluids. The latter may take two or three days.

When cleared, the section is removed to distilled water for fifteen minutes, the surplus segments providing a means of manipulating it with either needles or needle-pointed forceps without damaging or causing distortion of, the parts of the genitalia. At the end of this time, it is transferred first to 90 per cent. alcohol for ten minutes and then to a one per cent. solution of basic fuchsin in 95 per cent. alcohol for ten minutes. The staining is not essential but is desirable since, in pale-coloured specimens, some of the structures may become invisible during subsequent treatment.

From the stain, the section is put in absolute alcohol for ten minutes. From this it is removed to a drop of cedar-wood oil in a hollow-ground slide where it is moved to a lateral position so that the two harpagones and the two brachones are superimposed. Fine needles are used to arrange the section in this position, and movement is prevented by means of small fragments of glass placed round it. Using a ×10 ocular and a ×10 objective, a careful drawing of the genitalia is made.

The section is then turned so that its ventral surface is uppermost, kept in position as before, and drawn.

These drawings having been completed, the section is washed in xylol, and then placed in a drop of "Sira" or other permanent mountant on a microscope slide, where it is carefully dissected under a binocular. This is best done by rotation the genitalia till the ventral side is uppermost and then dividing the section in two by inserting a needle point at the base of the subgenital plates and carefully separating them with another needle. The membranes will be found to tear much more easily than the sclerotized parts of the genitalia. A cover slip is then applied.

From the slide so prepared, exact drawings can be made of all elements of the genitalia. For this work, I find a ×10 ocular and a ×40 objective satisfactory, fine details being checked by changing to a ×25 ocular, thereby getting a magnification of 1,000.

All the figures in this paper have been made from my own drawings of the actual insects and sections prepared as above, except Text-figures 14–19, which were drawn from the prepared genitalia of the type, and Text-figures 22–28, which are redrawn from Paoli (1936). For accuracy, these latter leave little to be desired. I have used a camera lucida for the drawings. By doing them myself, I am able to guarantee accuracy of detail.

Notes on Discarded Species, Misidentifications, and Synonymy.

Empoasca athertoni (Evans, 1941).

This is not a member of any genus of the Empoasciti. Lacking the necessary knowledge, I am not qualified to place it in its correct genus. It appears, as the following structural details show, to belong to the tribe Jassini of Evans (1947).

The face is very wide and short, its width being nearly twice its length.

The crown is extremely wide relative to the very short distance between its anterior and posterior margins, and the ocelli are on it near the anterior margin.

The tegmen has a large appendix, and shows little reduction in venation. In addition to the veins normally present in the empoascit tegmen, R_s, M_{1+2}, and a distinct Anal vein occur. All veins are strong and clearly evident in the basal part of the tegmen.

The hindwing also has a much more complete venation. In addition to the veins normally present in the empoascit hindwing, the following occur: Sc is a separate vein; R_{2+3}, R_{1+5}, M_{1+2}, and M_{3+4} are all present, as are both Cu_1 and Cu_2. There are three apical cells closed by the submarginal vein which terminates at the second Anal vein. These cells are cell R_{2+3}, cell M_{1+2}, and cell M_{3+4}.

The male genitalia are distinctive. The subgenital plates are very short and stout, while the aedeagus is very similar to that of members of the genus *Jassus*, and quite unlike that of any known genus of the Empoasciti.

"*Empoasca terrae-reginae*" for *E. viridigrisea* Paoli.

In 1941, Evans identified as *Empoasca terrae-reginae* Paoli a green leaf-hopper reported to be abundant in lucerne, on tomatoes and other vegetables, and on weeds, in both Queensland and New South Wales. At the same time he gave a partial description of the insect (Evans, 1941).

Amongst the material examined by me was a number of specimens identified by him as *E. terrae-reginae*. I carefully compared these and his description with Paoli's original description and figures of *E. viridigrisea* (Paoli, 1936). As the specimens and description agreed in every detail with Paoli's account, I came to the conclusion that Evans' "*E. terrae-reginae* Paoli" was, in fact, *E. viridigrisea* Paoli.

A number of specimens of this insect, including two identified as "*E. terrae-reginae*", together with a number of prepared genitalia, were submitted to the British Museum authorities with the request that they be compared with Paoli's type of *E. viridigrisea*. (All the specimens bore numbers only.)

They confirmed my opinion that the insects were *E. viridigrisea* Paoli and added, "we consider it identical with a species referred to by Dr. J. W. Evans as *Empoasca terrae-reginae* Paoli in *Proc. Roy. Soc. Queensland*, 52, p. 11, 1941".

This misidentification has been perpetuated since that date in the literature of economic entomology. The species must now revert to its correct name, *A. viridigrisea* Paoli, 1936.

Empoasca maculata Evans (1942*a*).

A study of Paoli's original description of *Empoasca terrae-reginae* (Paoli, 1936) leaves no doubt that *E. maculata* is a synonym for this species.

The subgenital plates, alone (see Text-figs. 22 and 57), are so highly characteristic as to be sufficient in themselves, but all other parts of the genitalia of *maculata* are identical with those of *terrae-reginae*. Both are yellow insects and each has a small brown spot on the tegmen. I figure the drawings of Paoli of both this species and his *viridigrisea*, and, in an appendix, include my translations of his descriptions so that the facts can be checked by anyone interested.

It is peculiar that this synonymy should ever have arisen since, as late as 1939, J. H. Smith (1939), in the Entomological Section of the Annual Report of the Queensland Department of Agriculture and Stock, was well aware that the Queensland cotton jassid was *E. terrae-reginae*, for he writes: "The cotton jassid, *E. terrae-reginae* Paoli, proved more serious than for some time past, and many areas were heavily infested late in the season. Work on this pest at the Biloela Research Station is a joint project between the plant breeder and the entomologist and strain resistance is a feature of present investigations."

It may be noted in passing that Paoli's type of *terrae-reginae* came from Biloela, where it was attacking cotton. The cotton jassid therefore reverts to its original name, *A. terrae-reginae* Paoli.

Empoasca pulcherrima Evans (1924*b*).

Having read Kirkaldy's original description of his *Cicadula histrionicula* (Kirkaldy, 1906), I was convinced that *E. pulcherrima* was a synonym for this species.

Specimens of *pulcherrima* were therefore sent to Mr. C. E. Pemberton, the Entomologist of the Hawaiian Sugar Planters' Association in Hawaii, asking him to compare them with Kirkaldy's type. His reply is as follows: "In comparing the specimens [of *E. pulcherrima*] with our type of *E. histrionicula* Kirk., I find no difference. Your three specimens vary slightly in colour pattern on the dorsum. The specimen in the center matches our specimen almost exactly. Though our specimen has lost its tegmina, the wings are still present, and the venation seems to match exactly the venation of your specimens. Your specimens are faintly larger; but I do not consider the difference significant. . . . I am strongly inclined to believe that your specimens are actually *E. histrionicula* Kirk."

Since *pulcherrima* corresponds exactly with Kirkaldy's description, this name must be discarded and the species revert to its original name of *histrionicula* Kirk.

Empoasca fabae Harris.

This insect has been recorded (Anon., 1944-1945) as attacking tomato plants in Queensland. This reference has been carefully checked and it appears that no identification of the insect was ever made. In view of the host plant, and the locality from where it was reported, it is virtually certain that the insect was *A. viridigrisea* Paoli, its general colour and pattern having much in common with those of the North American species, though the different shapes of the crown in each would easily differentiate them.

There is no evidence to suggest that *E. fabae*, or any other exotic species, occurs in any part of Australia.

THE GENUS AUSTROASCA, ITS SUBDIVISIONS, AND RELATIONS BETWEEN THE SPECIES.

The eight known species of *Austroasca* all share alike in the common heritage of the Empoasciti. Seven of the species, however, resemble each other much more closely than any one of them does the eighth.

The aberrant member of the genus is *A. bancrofti*, of which I have seen five specimens only. This is the only species of which I have had no material for microscopic preparations. Fortunately the tegmen and the genitalia of the type (male) have been separately mounted. Of the remaining specimens, two are complete females and two are females which have lost their abdomens.

For this species I erect the subgenus *Paolia* and distinguish it from the subgenus *Austroasca* s.str. as follows:

SUBGENUS PAOLIA, NOV.

The average size is considerably greater than that of species of *Austroasca* s.str.

The sutures of the head are complete and easily seen.

The venation of the tegmen is unique. R, instead of occupying its normal position (see R, Text-figs. 4, 37, 44, 52, 58, 67 and 74), runs parallel, and very close, to the costa (see R, Text-fig. 13), until about half-way along the tegmen, where it unites with the costa. It soon turns posteriorly and then apically uniting with M. The combined vein R + M gives off the branch R_{1a} to the costal margin and then forks into R_{1b} and M_{3+4}. In contrast to the venation of *Austroasca* s.str., where the cross-vein m-cu connects M_{3+4} only with Cu_1, in this subgenus it connects R + M with Cu_1 so that the three veins R_{1b}, M_{3+4}, and m-cu are all in contact at one point. This has been brought about by the basad movement of m-cu, its resulting increase in length making it as long as Cu_{1b}, though in *Austroasca* s.str. it is nearly always shorter, and usually very much shorter, than Cu_{1b}.

The genitalia apparently differ in certain respects from those of *Austroasca* s.str. A normal pygophore either has not been developed or has been damaged in mounting. A torn fragment (shown dotted in Text-fig. 14) may be part of a pygophore lobe.

The subgenital plates are much more weakly bristled than in other species of the genus, while the harpagones appear to lack bristles.

Unfortunately the spatial relation between the parts cannot be known at present. The genitalia of the type have been mounted after partial dissection, and Text-figure 14 is a reconstruction made from drawings, all on the same scale, of the separate parts. The possibility of serious error is obvious when such a procedure is adopted, and whether the position of the species in the subgenus is confirmed, whether it is shown to be merely an aberrant form within the genus, or whether its complete removal from *Austroasca* s.lat. is necessary, the future study of new material alone can decide. In putting it in a separate subgenus, it can be later eliminated, if necessary, without any alteration to *Austroasca* s.str.

While the seven remaining species of *Austroasca* form a more or less homogeneous group, three well-defined subgroups, based primarily on variation of the tegmen venation, can be distinguished. The variation in the venation can be correlated with the degree of specialization of the genitalia. When so grouped, genetic relationships are made clear and, at the same time, there is some indication of the evolutionary level attained by the various species.

I believe that the most generalized forms occur in the *viridigrisea* subgroup and that these probably most closely approach the austroascan ancestor in structure. In the tegmen of this group the combined vein R + M is present, r–m is therefore lacking, and R_{1a} meets the costal margin of the tegmen obliquely (Text-figs. 4 and 67). The subgroup contains two species, *viridigrisea* and *merredinensis*. Both species exhibit similar characters in the genitalia. The subgenital plates (Text-figs. 26 and 66) are short, wide, and possess relatively few strongly-developed ensiform bristles. The harpagones (Text-figs. 28 and 64) are relatively short and stout, and their denticulations are of similar pattern. Both have wide sail-like brachones (Text-figs. 27 and 63) with

broad two-pronged bases and tapering, curved, simple tips, while the free dorsal lobes of the aedeagus are curved in an open arc (Text-figs. 29 and 65).

The *histrionicula* subgroup is equally distinctive. It contains the species *histrionicula* and *malvae*. The tegmen venation is similar to that of the *viridigrisea* subgroup except that R_{1a} is vestigial, appearing as a mere thickening of R near where R_{1a} should fork. R_{1a} is not present as a distinct vein and does not reach the costal margin (Text-figs. 37 and 44). It may be fortuitous that the tegmina of both species show a similar colour pattern, and that the colours and pattern on the body generally are not unlike. The genitalia show that this subgroup has attained a higher evolutionary level than the first. The chaetotaxy of the subgenital plates (Text-figs. 34 and 43) is of a similar pattern and is of a more complex nature than that of the *viridigrisea* subgroup. A few flagellate bristles, though not well developed, are present. The harpagones are of a similar structure (Text-figs. 36 and 41). but it is in the brachones (Text-figs. 35 and 42), the most plastic feature of the genitalia of the Empoasciti, that the greatest changes have occurred. The broad two-pronged base has been lost, though the spur in *malvae* may be a vestige of a prong. The brachones are now slender and cylindrical, the terminal halves being straight with simple tapering tips. The aedeagus (Text-figs. 33 and 39) is very similar in each, the dorsal lobes assuming the form of short, thick, crescents.

The highest evolutionary development is to be found in the *terrae-reginae* subgroup, consisting of *terrae-reginae*, *alfalfae* and *bractigera*. In the tegmina, the cross-vein r-m is present since R and M retain their separate identities (Text-figs. 52, 58 and 74). R_{1a} meets the costal margin perpendicularly, though it may be difficult to see, as is the case in *bractigera*. The genitalia show the peak of evolution attained by known species of the genus. The chaetotaxy of the subgenital plates is obviously of the same pattern (Text-figs. 51, 57 and 71). All four types of bristles occur. There is a tendency towards the development of an abundance of long flagellate bristles which are so strongly developed in *terrae-reginae* that it can be identified by this character alone. The harpagones (Text-figs. 24, 50 and 73) have become short and stout, each terminates in a spine, and each bears a small number only of short stout bristles. The brachones (Text-figs. 23, 23A, 49 and 72) have undergone further modification, since there is now a tendency for their terminations to be sculptured. They are always strongly notched in *alfalfae*, saw-like, apically, in *bractigera*, and very often concavely notched in *terrae-reginae*. Text-figures 55, 47 and 70 show that the general arrangement of parts is similar in the three species.

Based on the above facts, I arrange the species in the following evolutionary scale. Of the known species I regard *viridigrisea* as the most generalized, followed in succession by *merredinensis*, *malvae*, *histrionicula*, *bractigera*, and *alfalfae*, with *terrae-reginae* as the most specialized species.

In view of the small number of known species, these ideas must be tentative, but, at the same time, the facts are suggestive.

Conclusion.

In this study I have conscientiously tried to apply those principles which I regard as essential to the satisfactory revision of any group. I have done much painstaking research, including a thorough study of types, and of all the literature bearing on the subject, more especially the original descriptions. I have given complete re-descriptions of all species needing it, together with, I hope, adequate illustrations. Finally, I have tried to make keys which will enable any entomologist who is prepared to familiarize himself with the characters used, and to make careful microscopic preparations, to ascertain what species he is identifying (if known), or to determine definitely whether it is an undescribed one. I believe I have laid a foundation on which those who follow can build with confidence.

Note: In Table 1 is shown the number of specimens of each species examined and the locations where these were collected; in Table 2 a list of the known food plants of each species is given.

TABLE 1.

Showing Numbers of Specimens Studied and Districts where These were Collected.

	A. viridigrisea.			*A. terraereginae* 1.			*A. alfalfae* 2.			*A. histrionicula* 3.			*A. malvae* 4.			*A. merredinensis* 5.			*A. bancrofti* 6.			*A. bractigera* 7.		
	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.
Queensland—																								
No district	1	2	3	—	—	—	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ayr.. ..	15	16	31	—	—	—	10	8	18	—	—	—	4	4	8	—	—	—	—	—	—	—	—	—
Biloela ..	4	7	11	2	4	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bowen ..	10	12	22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Boyne River	—	—	—	6	5	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brisbane ..	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brookfield	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Callide ..	1	3	4	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cambooya	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Charters Towers ..	4	5	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eidsvold ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	3	—	—	—
Gatton ..	1	1	2	—	—	—	—	—	—	2	2	4	2	4	6	—	—	—	—	—	—	—	—	—
Gayndah ..	3	5	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gracemere	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Horne Hill	—	—	—	—	—	—	2	2	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Humphrey	—	—	—	10	15	25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Indooroopilly	1	3	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Jandowae ..	2	1	3	3	3	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Kilmore ..	—	—	—	2	4	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Kingaroy ..	—	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Kongaroy ..	2	2	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mimgary ..	—	—	—	2	1	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mundubbero	—	—	—	1	5	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pentland ..	2	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rockhampton	—	—	—	—	—	—	—	4	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Toowong ..	—	—	—	—	—	—	—	—	—	1	3	4	—	—	—	—	—	—	—	—	—	—	—	—
Yamala ..	—	—	—	1	3	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Yeeroongpilly	1	—	1	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
New South Wales—																								
Bellbrook	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bolwarra ..	2	3	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Branxton ..	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Camboyne	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cabramatta	—	1	1	—	—	—	3	9	12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dundas ..	—	3	3	—	—	—	3	6	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dungog ..	—	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gunnedah	1	2	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Maitland ..	—	7	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Millthorpe	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mount Keira	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
Mudgee ..	4	5	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Narellan ..	8	8	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nemingha	1	2	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Paterson ..	7	3	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pitt Town..	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Prospect ..	12	11	23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Raworth ..	5	4	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Roslyn ..	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Seaham ..	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sydney ..	1	4	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	—	—	—
Tamworth	3	5	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wauchope	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wilberforce	3	4	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Windsor ..	1	2	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wingham	1	4	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

TABLE 1.—*Continued.*

Showing Numbers of Specimens Studied and Districts where These were Collected.—Continued.

	A. viridigrisea.			*A. terrae-reginae* 1.			*A. alfalfae* 2.			*A. histri-onicula* 3.			*A. malvae* 4.			*A. merred-inensis* 5.			*A. ban-crofti* 6.			*A. brac-tigera* 7.		
	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.	♂	♀	Total.
Victoria—																								
Nathalia ..	—	5	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
South Australia—																								
Athelstone..	1000	1000	2000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Berri ..	11	12	23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Marion ..	11	15	26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mitcham ..	18	25	43	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Renmark ..	6	8	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Western Australia—																								
Bridgetown	2	2	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Kenwick ..	5	11	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Manjimup	2	3	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Merredin ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	17	27	—	—	—	—	—	—
Perth ..	6	5	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wyndham	12	14	26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tasmania—																								
No species known																								
Grand totals	1174	1239	2413	27	40	67	20	32	52	3	5	8	6	8	14	10	17	27	1	4	5	1	—	1

Key to genus Austroasca *nov.*

m-cu connecting M_{3+4} with Cu_1; R in normal position .... subgenus *Austroasca*
m-cu connecting R + M with Cu_1 (Text-fig. 13); R abnormally close to C .... subgenus *Paolia*

Subgenus *Austroasca* nov. Males.

1. Crown conspicuously marked with brownish-black 2
   Crown not marked with brownish-black 3
2. (1) Four brown marks on crown in form of separate longitudinal bands touching anterior margin (Text-fig. 30) ..... *malvae* Evans (1942*b*)
   Two brown marks on crown either roughly U-shaped or subquadrangular, not touching anterior margin (Text-figs. 38, 38A) ..... *histrionicula* Kirkaldy (1906)
3. (1) Brachone with wide base (Text-figs. 27, 63) 4
   Brachone with narrow base 5
4. (3) Termination of brachone long, slender and much recurved (Text-fig. 63) .... *merredinensis*, sp. nov.
   Termination of brachone short, thick and curved (Text-fig. 27) .... *viridigrisea* Paoli (1936)
5. (3) Brachones expanding to form broad plates, toothed on distal margins (Text-fig. 72) .... *bractigera*, sp. nov.
   Brachone slender 6
6. (5) Brachone strongly angled, tip deeply notched (Text-fig. 49) ..... *alfalfae* Evans (1941)
   Brachone almost straight (Text-fig. 23); tip sometimes concavely notched (Text-fig. 23A) ..... *terrae-reginae* Paoli (1936)

Subgenus *Austroasca* nov. Females.

1. Crown conspicuously marked with brownish-black 2
   Crown not marked with brownish-black 3
2. (1) Four brown marks on crown in form of separate longitudinal bands touching anterior margin (Text-fig. 30) ..... *malvae* Evans (1942*b*)
   Two brown marks on crown either roughly U-shaped or subquadrangular, not touching anterior margin (Text-fig. 38, 38A) ..... *histrionicula* Kirkaldy (1906)
3. (1) Cross-vein r-m present in tegmen 4
   Cross-vein r-m absent in tegmen 6
4. (3) Tegmen with a small brown spot in cell Cu_1 near forking of Cu_{1b} (Text-fig. 58) .... *terrae-reginae* Paoli (1936)
   Tegmen without such a spot 5

5. (4) Crown distinctly, obovately produced C.I. = 23 (Text-fig. 45) .... *alfalfae* Evans (1941)
Crown very little produced C.I. = 10 (Text-fig. 68) ..... *bractigera*, sp. nov.
6. (3) R_{1a} directed towards base of tegmen (Text-fig. 67). Brownish insects .....
..... *merredinensis*, sp. nov.
R_{1a} directed towards apex of tegmen (Text-fig. 4). Greenish or greyish insects .....
..... *viridigrisea* Paoli (1936)

Subgenus *Paolia* nov.

Head yellow with three oval black marks, two on crown, and a median one high on face
..... *A.* (*Paolia*) *bancrofti* Evans (1939)

TABLE 2.

Recorded Host Plants of Species of Austroasca.

Species.	Breeding and Feeding on.	Feeding Only.
viridigrisea	Potato. Tomato. Lucerne. French bean. Rock melon. *Solanum nigrum* L. *Chenopodium album* L. *Malva parviflora* L. *Amaranthus viridis* L. *Citrullus vulgaris* Schrad. Tobacco. Silver beet.* Cotton.* *Trianthema portulacastrum* L.* *T. decandra* L.* *Ricinis communis* L.*	*Cynodon dactylon* Richard. Celery. *Portulacca oleracea* L. *Bidens pilosa* L.* *Tribulus terrestris* L.*
merredinensis	*Atriplex* sp.	
malvae	*Malva parviflora* L.* *Abutilon* sp.	
histrionicula	*Sida subspicata* F. v. M. *S. rhombifolia* L.*	Cotton.*
alfalfae	Poona pea (*Vigna sinensis* L.).* *Pisum sativum* L.* Lucerne.* Cotton.* *Crotalaria* sp.* French bean.	Potato.*
terrae-reginae ..	Cotton. *Sida corrugata* L.* *Abutilon* sp.*	*Amaranthus viridis* L.* *Chenopodium carinatum* R.Br.* *Clerodendron tomentosum* R.Br.*
bancrofti	No hosts recorded.	No hosts recorded.
bractigera	No hosts known.	No hosts known.

* Information from May, 1950.

AUSTROASCA (AUSTROASCA) VIRIDIGRISEA PAOLI (1936).

(Text-figures 1–11, 24–29.)

Empoasca viridigrisea Paoli, *Mem. Soc. Ent. Ital.*, 15, 1936: 12–13.

Empoasca terrae-reginae Evans, *Proc. Roy. Soc. Queensland*, 52, 1941: 11.

Suggested common name, the vegetable jassid. *Length.*—Male: Average of 1,174 specimens, 3·8 mm.; max. 4·0 mm., min. 3·5 mm. Female: Average of 1,239 specimens, 3·9 mm.; max. 4·2 mm., min. 3·8 mm. *Colour*: Green with white markings.

Head.—Crown: C.I. = 13 (Text-fig. 1). Anterior margin gently curved. Emerald green with narrow, irregular median, white stripe, four lateral white spots, one on

anterior margin close to each eye, and one posterior to each of these. Coronal suture incomplete. *Face*: Shape typical (Text-fig. 2). Yellowish-green with white, irregular, narrow, median white stripe from vertex to level of antenna bases. The pattern varies considerably, some specimens showing more white than others. Two white bands, one from below each ocellus, and directed outwards. *Antennae* typical, scape and pedicel green, third segment and remainder of antenna dark green (Text-fig. 3). *Ocelli* two, high on face, one between median and each eye, each in centre of yellowish-white, circular spot. *Eyes* dark brown.

Thorax.—Pronotum (Text-fig. 1): Anteriorly yellowish-green becoming translucent and paler posteriorly; an irregular median white spot, and four lateral white spots, two on each side. All spots on anterior margin. *Scutellum* (Text-fig. 1): Emerald green, yellowish laterally. A complex, characteristic, white median mark (Text-fig. 1A) and a long, white, irregular stripe along each lateral margin. The median mark varies little in shape; in a few specimens it is not forked.

Wings.—Tegmen (Text-fig. 4): Basal four-fifths yellowish and opaque, almost concealing venation, which is typical. Apical fifth brownish to colourless hyaline. Veins green and obvious in clear apical area. *Hind Wing* (Text-fig. 5) typical, colourless hyaline, veins prominent and green. *Legs* typical, green, tending to peacock blue distally. Pretarsi dark brown.

Abdomen.—Typical of genus. Dorsal surface green, ventral surface yellow to yellowish-green. *Genitalia* deep green (Text-figs. 6 and 7). *Subgenital plate* (Text-fig. 26) short and broad, with about fifteen stout ensiform bristles and about fourteen long thin hairs on dorsal edge near base. *Harpagone* (Text-figs. 8 and 28): About eight teeth and four stout bristles. *Brachone* (Text-fig. 27) subtriangular with broad base, rapidly tapering to a blunt point; termination curved. *Aedeagus* (Text-fig. 29): Free dorsal part curved in an open arc.

Type in British Museum.

Type locality.—Bowen, near Pomodori, Queensland, Australia, October 20, 1931 (D. O. Atherton).

Host plants.—See Table 2.

Austroasca (Austroasca) merredinensis, sp. nov.

(Text-figures 59–67.)

Length.—Male: Average of 10 specimens, 3·9 mm.; max. 4·0 mm., min. 3·9 mm. Female: Average of 17 specimens, 4·4 mm.; max. 4·5 mm., min. 4·3 mm. *Colour*: General colour light brownish, showing no pattern. (Specimens have been preserved in alcohol.)

Head.—Crown: C.I. = 27. Anterior margin bluntly angularly produced, brownish (Text-fig. 59). *Face* typical, brownish. *Antennae* typical, brownish. *Ocelli* high on face. *Eyes* bleached to white by alcohol.

Thorax.—Pronotum: Anterior margin bluntly angled so as to be more or less parallel with anterior margin of crown (Text-fig. 59). *Scutellum* (Text-fig. 59) brownish.

Wings.—Tegmen (Text-fig. 67) light brown to colourless hyaline. Venation typical. *Hind Wing* colourless, venation typical. *Legs* brownish, typical.

Abdomen brownish, typical. *Genitalia* (Text-figs. 60 and 61). *Subgenital plate* (Text-fig. 66) short and broad. About 20 strong ensiform bristles; lower margin with a fringe of about twelve thinnish bristles about half the length of the strongest central ensiform bristle. Apical two-thirds of upper margin with marginal setae. Apex of plate terminating in a concavity. *Harpagone* (Text-fig. 64) short and stout, apical part curved with about eight or nine denticulations. Setae in two rows: an outer row of three strong bristles and an inner row of three or four bristles not so long as outer bristles. *Brachone* (Text-fig. 63) wide at base, rapidly tapering to a long, thin, very recurved tip, terminating in a sharp point. *Aedaegus* (Text-fig. 65): Free dorsal part curved in an open arc.

Type material.—Male holotype; tegmen and dissected genitalia mounted; remainder of body in alcohol.

Type material in Coll. Division of Entomology, C.S.I.R.O., Canberra, A.C.T.

Type locality.—Merredin, Western Australia, April 3, 1940. "On Saltbush" (C. F. H. Jenkins).

Host plant.—*Atriplex* sp.

Austroasca (Austroasca) malvae Evans.

(Text-figures 30-37.)

Empoasca malvae Evans, *Proc. Roy. Soc. Queensland*, 54, 1942: 49. (Note: The numbers 3 and 6 in Evans' figures should be transposed.)

Length.—Male: Average of six specimens, 3 mm.; max. 3·1 mm., min. 2·9 mm. Female: Average of eight specimens, 3·5 mm.; max. 3·7 mm., min. 3·3 mm. *General Colour* greenish-yellow with brown markings.

Head.—Crown: C.I. = 19 (Text-fig. 30). Pale green with four irregular longitudinal brown stripes, one bordering each eye. Coronal suture incomplete. *Face* normal, yellowish with a broad, median, irregular, longitudinal, white stripe. *Antennae* normal, greenish. *Ocelli* close to eyes, one in each lateral pale green band on lower part of corono-facial angle. *Eyes* brown.

Thorax.—Pronotum (Text-fig. 30) generally light brown with median greenish-white mark immediately posterior to median pale green band of crown and a white mark near each antero-lateral margin. Between each of these and the median mark is a sub-oval white mark. Posterior median section translucent and greenish yellow; posterior lateral lobes pale green. *Scutellum* (Text-fig. 30) yellowish-brown with a median white oval spot continued posteriorly as a median greenish-white stripe to suture, where it expands to a large sub-oval white blotch. On either side of median white blotch on anterior of scutellum is a dark band. Tip of scutellum pale green.

Wings.—Tegmen (Text-fig. 37): Apical third brown hyaline, a wide greenish area along costal margin between that margin and Cu_1. Area posterior to Cu_2 largely brownish-yellow except the two whitish translucent areas shown. Area between Cu_1 and Cu_2 chiefly whitish translucent. Veins greenish-white. *Hind Wing* normal. *Legs* normal, green.

Abdomen normal greenish. Most of posterior of each tergite occupied by a large brown area, the anterior being yellowish-green. Posterior of ninth tergite with an almost black transverse band. Ventral surface yellowish-green. *Genitalia* pale green (Text-figs. 31 and 32). *Subgenital plate* (Text-fig. 34) long, broad at base and gently tapering. About 25 strong ensiform bristles. Near centre of plate are three flagellate bristles, while a few shorter such bristles occur above these near the upper margin. Terminal fifth of upper margin with marginal setae. Near base of plate and on upper margin is a group of long hairs followed by six to seven short ensiform-like bristles. *Harpagone* (Text-fig. 36) short and stout with between five and six denticulations and four bristles. *Brachone* (Text-fig. 35) short, slender, curved and simple, with an upward-directed spur near base. *Aedeagus* (Text-fig. 33): Free dorsal part in form of a thick crescent.

Type.—Male mounted on point, in Coll. Queensland Museum. HÓ5233.

Type locality.—Gayndah, Queensland, April 7, 1942. "On *Sida subspicata*" (A. May).

Austroasca (Austroasca) histrionicula Kirkaldy (1906).

(Text-figures 38–44.)

Cicadula histrionicula Kirkaldy, *Haw. S.P. Exp. Sta. Entom. Bull.*, 1, part 9: 361.

Empoasca histrionicula Myers, *Bull. Ent. Res.*, 18, 1928: 311.

Empoasca pulcherrima Evans, *Proc. Roy. Soc. Queensland*, 54, 1942: 49. (Note: The numbers 3 and 6 in Evans' figures should be transposed.)

Length.—Male: Average of three specimens, 2·7 mm.; max. 2·75 mm., min. 2·7 mm. Female: Average of five specimens, 2·8 mm.; max. 2·9 mm., min. 2·7 mm. *Colour* yellowish-green with conspicuous brown markings.

Head.—Crown: C.I. = 17 (Text-fig. 38). Slightly produced, light green, most of its area occupied by two large U-shaped almost contiguous dark brown marks. These

marks vary considerably in shape. Frequently they are U-shaped, the arm of the U nearer the median line being longer, but in many specimens the colour "overflows" so as to make the marks roughly subquadrangular, as is the case in Kirkaldy's type (Text-fig. 38A). *Face* typical. Fronto-clypeus lemon yellow, ante-clypeus and labrum light green. *Antennae* green. *Ocelli* high on face, each nearer the eye than median line. *Eyes* dark brown.

Thorax.—Pronotum (Text-fig. 38) with a broad, median, velvety, brown band; laterally, pale green. *Scutellum* (Text-fig. 38) wholly dark brown.

Wings.—Tegmen normal, pale yellowish-green with large dark brown area (Text-fig. 44). *Hind Wing* normal. *Legs* normal, yellowish-green.

Abdomen.—Normal, yellowish in colour, a large subtriangular brown area covering most of the terga. Tergum of ninth segment brownish-black, a narrow yellow lateral band on posterior of eighth tergite intervening between the two brown areas. Sternal surface entirely yellow. Anal tube wholly dark brown. *Genitalia* (Text-figs. 39 and 40): In both sexes the basal half is yellowish, the terminal half brown, intensifying to black at the tips (Text-fig. 43). *Subgenital plate* (Text-fig. 43) long, basal third wide, apical two-thirds tapered with upper and lower margins subparallel; nine or ten ensiform bristles present. Terminal half of upper margin with marginal setae. On upper margin near base are three or four small hairs followed by four or five small ensiform-like bristles and three or four flagellate type bristles. *Harpagone* (Text-fig. 41): Basal third wide, apical two-thirds slender and almost straight. Nine to ten denticulations, four or five small slender bristles in two series. *Brachone* (Text-fig. 42) strongly elbowed at base, then straight, more or less cylindrical, tapering suddenly to a point, twisted. *Aedeagus* (*a*, Text-fig. 39): Free dorsal part in form of a thick crescent.

Type.—Female mounted on point. In Coll. Haw. Sug. Planters' Assn., Honolulu, Hawaii.

Type locality.—Bundaberg, Queensland. Collected by Koebele and Perkins' expedition in 1904.

Austroasca (Austroasca) bractigera, sp. nov.

(Text-figures 68–74.)

Length.—Holotype male, 3·6 mm. (only specimen known). *Colour* yellow.

Head.—Crown (Text-fig. 68) extremely slightly produced; C.I. = 10. Bright yellow with faint white stripe on coronal suture, which is incomplete. *Face* normal and yellowish. *Antennae* normal, brownish-yellow, flagellum brown. *Ocelli* two, close to eyes, and level with top of post-frontal suture. *Eyes* brownish-black.

Thorax.—Pronotum (Text-fig. 68) robust; yellow possibly marked with white on anterior margin. *Scutellum* yellow with apparently two white lateral bands and a terminal white patch.

Wings.—Tegmen (Text-fig. 74) normal, brownish-yellow and hyaline. Cross vein r-m present, R_{1a} weakly developed; near base in cell Sc is a series of five circular protuberances, and two elongated raised patches formed by the union of a number of similar protuberances. *Hind Wing* colourless; venation normal, veins white. *Legs* normal, yellow.

Abdomen.—Yellow dorsally and ventrally, white laterally. *Genitalia* (Text-figs. 69, 70) yellow. *Subgenital plate* (Text-fig. 71) long, the distal half very narrow with dorsal and ventral margins subparallel. Ensiform bristles in two series; near apex are three or four well-developed flagellate bristles; marginal setae also present. *Harpagone* (Text-fig. 73) short and robust; about thirteen denticulations terminating in a curved spine; four to five bristles; base rugged. *Brachone* (Text-fig. 72): In its shape the brachone of this species is quite unique. It is short and from a narrow base opens out into a broad flat plate with its apical margin notched like a saw. The brachone, alone, will at once identify this species. *Aedeagus* (*a*, Text-fig. 69): The aedeagus is relatively large. Its attached basal part is narrow but soon widens and gives off a second strong point of attachment. The two free lobes are curved in an open arc.

Type.—Holotype male, mounted on card; genitalia separately mounted. In Coll. Department of Agriculture, Sydney, New South Wales.

Type locality.—Only one specimen, the type, is known. This came from Mt. Keira, New South Wales, and bears the label "Mt. Keira, New South Wales, at light 3.12.1949. C. E. Chadwick".

Austroasca (Austroasca) alfalfae Evans.

(Text-figures 45–52.)

Empoasca alfalfae Evans, *Proc. Roy. Soc. Queensland*, 52, 1941: 11.

Length.—Male: Average of 20 specimens, 2·75 mm.; max. 2·85 mm., min. 2·7 mm. Female: Average of 32 specimens, 3·6 mm.; max. 3·8 mm., min. 3·4 mm. *Colour* yellowish-green.

Head.—Crown: C.I. = 23. Obovately produced, yellowish-green (Text-fig. 45). *Face* normal, yellowish-green. *Antennae* normal, green. *Ocelli* two, one much nearer each eye than median line, near upper limit of face. *Eyes* dark brown.

Thorax.—Pronotum (Text-fig. 45) yellowish-green apparently unmarked with white. *Scutellum* yellowish-green with indefinite white markings, green towards lateral margins.

Wings.—Tegmen (Text-fig. 52): Venation normal; the erect vein R_{1a} is a characteristic of this and the next species. Cross-vein r-m present. Basal two-thirds of tegmen thickened, yellowish-green and translucent; apical third colourless hyaline. *Hind Wing* normal, veins pale green. *Legs normal*, yellowish-green.

Abdomen.—Normal, yellowish-green darkening towards posterior end. *Genitalia* (Text-figs. 46, 47) green. *Subgenital plate* (Text-fig. 51) relatively short, its upper and lower margins subparallel. About fifteen ensiform bristles, the uppermost near the base much longer and stronger than the others. Apical half of upper margin with marginal setae. A series of six or seven hairs on upper margin near base. Scattered over the "body" of the plate are long flagellate hairs which are very abundant towards its lower apical region. *Harpagone* (Text-fig. 50) short and stout, terminating in a spine-like point, with three or four denticulations, and with three short stout bristles. *Brachone* (Text-fig. 49) slender and strongly angled upwards about half-way along its length, where it is narrowest. It then widens for half the remainder of its length and is then notched strongly, terminating in a long, stout-pointed portion. *Aedeagus*: Free dorsal lobes somewhat ovate. *Dorsal hook* (Text-fig. 48 and *ds*, fig. 46): an extremely small dorsal hook can be seen under a magnification of 1,000.

Type.—Male, mounted on point in Coll. Queensland Museum, Ho. 5225.

Type locality.—Lockyer, Queensland, Australia, November 6, 1939 (D. O. Atherton), "On lucerne".

Austroasca (Austroasca) terrae-reginae Paoli.

(Text-figures 53–58 and 22–25.)

Empoasca terrae-reginae Paoli, *Mem. Soc. Ent. Ital.*, 15, 1936: 13–14.

Empoasca maculata Evans, *Pap. Proc. Roy. Soc. Tasmania*, 1942: 27.

Suggested common name, the cotton jassid.

Length.—Male: Average of 27 specimens, 3·3 mm.; max. 3·6 mm., min. 3·0 mm. Female: Average of 40 specimens, 4·0 mm.; max. 4·2 mm., min. 3·9 mm. *Colour* yellow with white markings.

Head.—Crown (Text-fig. 53) distinctly produced in a blunt angle. C.I. = 27. Yellow with median, longitudinal, narrow, irregular white stripe, and two sub-oval lateral white marks, midway between eyes and coronal suture. *Face* normal, yellow with broad, white, median, longitudinal stripe and two white stripes from middle of upper part of face directed diagonally towards lower margin of each eye. In many specimens the three stripes are united above to form a broad arrow. Frontal and epicranial sutures obvious. *Antennae* normal, brownish-yellow. *Ocelli* two, one very close to each eye on upper part of face. *Eyes* black.

Thorax.—Pronotum (Text-fig. 53) long, about twice crown length, yellow, with five white marks close to anterior margin, one median and two laterally. These five marks

vary greatly in size and shape but their number and position are constant. *Scutellum* (Text-fig. 53) yellow with a large subrectangular median white blotch between suture and anterior margin of scutellum, lateral margins white. Posterior to suture is a small elongate median white blotch; the two anterior lateral parts of this area are white.

Wings.—Tegmen (Text-fig. 58) normal, colourless hyaline with a small brown irregular spot in cell Cu_1 near the forking of Cu_{1b}. The colour of the spot varies from dark brown to yellowish and its shape is very variable. Its area and position are constant. In cell Sc and near the base of the tegmen is a line of small, circular, colourless protuberances varying in number between twelve and sixteen. Posterior to these is a small raised area formed by the union of from seven to nine such protuberances. A larger protuberance commonly occurs in cell M and a smaller one posterior to it in cell Cu_1. Cross-vein r-m present; R_{1a} perpendicular to costal margin. *Hind Wing* normal, colourless, veins white. *Legs* normal, yello v.

Abdomen.—Normal, dorsally yellow, ventrally yellowish-white. *Genitalia* (Text-figs. 54, 55) yellow, highly characteristic. *Subgenital plate* (Text-fig. 57) extremely long and narrow, its length being approximately ten times its greatest width. About twelve well-developed ensiform bristles. Near its apex ventrally is a number of extremely long flagellate bristles, while a row of similar but somewhat shorter bristles occur along the terminal half of the upper margin, which bears marginal setae in the same region. Towards the base and on and near the upper margin is a group of long thin hairs. The flagellate bristles are so long as to give the plates a hairy appearance even to the naked eye. *Harpagone* (Text-fig. 24) short and stout, terminating in a spine; seven to eight denticulations; three short stout bristles. *Brachone* (Text-fig. 23) extremely long and slender, slightly angled about one-quarter from its base, then straight with a small upcurved tip. Many specimens show a concave notching at the tip (Text-fig. 23A). *Aedeagus* (Text-fig. 56). Free dorsal part curved in an open arc.

Type.—Genitalia dissected and mounted separately, in Coll. British Museum.

Type locality.—Biloela, Queensland, Australia, January 4, 1932 (D. O. Atherton), "From cotton".

Austroasca (Paolia) bancrofti Evans.

(Text-figures 12–19.)

Empoasca bancrofti Evans, *Pap. Proc. Roy. Soc. Tasmania*, 1938: 40.

Length.—Male: One specimens (the type), 4 mm. (Evans' measurement). Female: Two specimens, 5·1 mm., 5·2 mm. (two specimens have the abdomens missing but are adjudged as females on other evidence). *Colour* yellowish with brown markings.

Head.—Crown (Text-fig. 12): C.I. = 12–13. Bright yellow with two oval blackish spots, one posterior to each ocellus. Coronal suture complete. *Face* normal in shape, but differs from all other species in having the coronal, frontal and epicranial sutures all complete and well defined; bright yellow with median, oval, black spot just above level of antenna bases. *Antennae* normal; scape and pedicel yellow; third segment and flagellum brown. *Ocelli* two, orange in colour, one between each eye and median line. *Eyes* black.

Thorax.—Pronotum (Text-fig. 12) yellowish with large, median, transverse, crescentic brown area, the whole finely white pollinose. *Scutellum* (Text-fig. 12) yellow medially with two lateral brown areas and a median apical brown spot.

Wings.—Tegmen (Text-fig. 13): Venation unique; R runs parallel to and very close to C + Sc, uniting with the latter about half-way along the costal margin. It then turns sharply posteriorly and after a bend unites with M, the combined vein R + M continuing on, giving off the branch R_{1a} and eventually forking into R_{1b} and M_{3+4}, thereby eliminating the cross-vein r-m. The cross-vein m-cu, by moving basad, has lengthened, and its anterior termination meets R_{1b} and M_{3+4} at the one point. Along the costal margin is a blue-black band which fills the whole of the area between C and M from the base of the tegmen to the point where R combines with M. A similar blue-black area extends along the posterior margin to the union of Cu_2 with that margin. Scattered over the basal half of the tegmen is a number of small circular protuberances, colourless

in the colourless part and black when these occur in the blackened areas. The remainder of the tegmen is milky white and translucent. *Hind Wing* not studied in detail for reasons given above. Milky white and translucent, veins white. *Legs* normal, yellowish.

Abdomen.—Normal; dorsal surface yellow with median row of brown spots extending along its whole length, two similar rows of lateral brown spots, one on each side of each tergum; ninth tergum and anal tube entirely brown. *Genitalia* yellow (Text-figs. 14, 15). Female genitalia as in genus; male genitalia abnormal. Text-fig. 14 has been reconstructed as explained above. *Pygophore* appears to be quite abnormal, there being no true pygophore as generally understood. This is possibly due to defects in preparation of the material. *Subgenital plate* (Text-fig. 18) short and tapering. Near lower basal margin are five ensiform bristles; after a gap there follow twelve small ensiform bristles and six small bristle-like hairs near the apex; marginal setae, flagellate bristles and fine hairs appear to be missing. *Harpagone* (Text-fig. 16) large, stout, twisted, but apparently of a simple type; the end is broadly rounded with five blunt teeth; there is no sign of bristles. *Brachone* (Text-fig. 17) long, slender, curved at the tip. *Dorsal hook* (Text-fig. 19), although much smaller than in other genera of the Empoasciti, is larger than in any other species of *Austroasca* s.lat. Its tip bears a V-shaped ridge and it is strongly sclerotized. *Aedeagus* has been torn in the type genitalia and its shape cannot be made out.

Type material.—Holotype male mounted on pin. Genitalia and tegmen mounted separately. In Coll. Division of Entomology, C.S.I.R.O., Canberra, A.C.T.

Type locality.—Eidsvold, Queensland, Australia (T. Bancroft). In view of the paucity of material (I have not yet seen a complete male) the status of this species must be somewhat conjectural. The complete sutures of the head and the abnormal tegmen venation are features common to the five specimens examined, but no certainty can be arrived at until I have thoroughly examined and dissected a complete male. Only in this way will it be possible to determine the exact nature of the parts of the genitalia and their spatial relationship. When I have had the opportunity of so doing, certain of the above statements may need modification.

Appendix.

Translations of Paoli's descriptions of *A. viridigrisea* and *A. terrae-reginae.*

A. VIRIDIGRISEA.

"Colour of body (when dry) greyish green, with almost colourless tegmina; eyes very pale.

Head with vertex rounded in the male (in the female?), its length not much more than half the width between the eyes (7:12), with its posterior margin somewhat incurved.

Tenth abdominal segment rather short, the ventral surface with a sprinkling of very short spines united into comb-like groups; processes of the anal tube [dorsal hooks] very short in the form of small protuberances, weakly sclerotized.

Aedeagus strongly curved in the free terminal part.

Genital laminae [subgenital plates] short and broad with the ensiform bristles moderately dispersed; on the upper margin is a group of rather numerous (about 12) long bristles, the remainder bearing short bristles; sternal surface with a fringe of medium length bristles about half as long as the width of the lamina.

Upper styli [brachones] well protected, concealed, wide at the base, then rapidly narrowing and curving, sharp at the apices.

The lower styli [harpagones] wide at the base, then gradually tapering and recurved with 4–5 lateral bristles and 8–9 teeth at each apex.

The abdominal apodemes appear to be missing, since, in the one preparation that I was able to make, and that comprising almost the entire abdomen, these could not be traced.

Body length of the male (when dry) mm. 1·9–2, including the wings 2·8–2·9.*

* These measurements are much smaller than in any specimen I have seen.—*Author.*

Habitat: Bowen, Queensland (Australia) near Pomodori. (Sent by D. O. Atherton.)

I have seen three males in the British Museum Collection. These are labelled:

Bowen, Q. 20.10.31, D.O.A.
Queensland. R. Veitch.
Host: Tomato, D. O. Atherton.

Type in British Museum.

Observations: This species, by the reduction of the upper styli and the probable lack of abdominal apodemes is most closely allied to *E. decedens* Paoli, but the aedeagus is not sclerotized nor curved at an angle at the tip."

A. TERRAE-REGINAE.

"Body wholly pale yellow (when dry) with colourless tegmina; eyes almost black, ocelli brownish.

Head anteriorly rounded in the male, slightly more produced in the female; the length of the vertex is a little more than half the width between the eyes. The long pronotum is one and a half times the length of the head with its posterior margin a little incurved.

The tenth abdominal segment has its ventral surface uniformly covered with spines for the whole of its length; the processes of the anal tube [dorsal hooks] are short, bent into straight teeth incurved at the apices. The free slender part of the aedeagus is curved in an arc.

Laminae [sub-genital plates] long, straight, with the greatest width near the basal part, and narrowing towards the apices; the ensiform bristles are of two kinds; those near the apices are fine, about 4–5 times as long as the width of the lamina, and terminate in flagella; towards the base they assume the normal form, but are always fairly long; both kinds overlap in the medial region; the upper margin bears rather slender bristles but these are shorter than those of the lower margin; in the basal half, marginal setae are lacking on the upper margin. The sternal surface bears short setae situated almost in the middle of the distal half; these become thin and very long on the basal half.

The elongated upper genital styli [brachones] are almost straight with a slight curve very near their apices; sometimes, at the curve the style shows a slight concavity.

The lower genital styli [harpagones] gradually taper with 2–3 big bristles at the distal half and 7–8 teeth near the tip, which is prolonged into a sharp point.

Abdominal apodemes not seen through scarcity of material.

Length of body of male mm. 2·3; including the wings mm. 2·8; of the female 2·1–2·3; including the wings 2·8–2·9.

Habitat: Biloela, Queensland (Australia), from D. O. Atherton. I have seen 2♂ and 2♀ collected from cotton, 4th January, 1932 (British Museum). These are labelled:

Biloela,
4.1.32,
From Cotton,
D. O. Atherton,
Queensland.

Type in British Museum.

Observations: In some characters, such as size and pale coloration, this species shows affinities with *E. facialis* Jac., but more particularly through the long straight laminae bearing abundant and long bristles. The scarcity of material has prevented my examining other features such as the presence and shape of the abdominal apodemes but *the characters indicated above are so specialized that they are sufficient for the precise determination of the species.*" *

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* The italics are mine.—*Author.*

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EXPLANATION OF PLATE XV.

Left.—Portion of stem of black nightshade (*Solanum nigrum*), × 0·8. Plant has been killed by feeding of *A. viridigrisea*.

Right.—Typical damage done by feeding of *A. viridigrisea*. 1. Leaf of *Amaranthus viridis*. The black specks are the execreta of the insects. 2. Leaf of *Malva parviflora* (small-flowered mallow). 3. Leaf of *Medicago sativa* (lucerne). 4. Leaf of *Apium graveolens* (celery). 5. Leaf of *Citrullus vulgaris* (pie-melon).